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(71)Applicant : TOSHIBA CORP

(72)Inventor : TAKAMI NORIO
HASEBE HIROYUKI
OSAKI TAKAHISA
KANDA MOTOI

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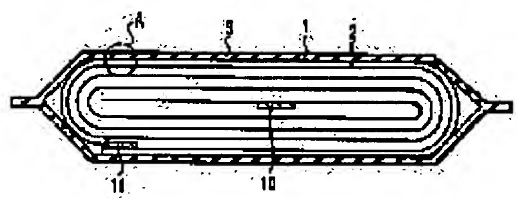
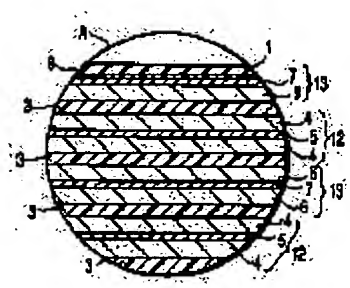
(54) NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent an exterior packaging material of a secondary battery from swelling by restraining the generation of gas when stored at high temperatures as well as to improve large current discharge characteristics and charge/discharge cycle characteristics.



SOLUTION: This secondary battery is equipped with an electrode group 2 comprising a positive electrode 12, a negative electrode 13 including a material for occluding/releasing a lithium ion, and a separator 3 arranged between the positive electrode 12 and the negative electrode 13; a nonaqueous electrolyte impregnated into the electrode group 2 and including a nonaqueous solvent and a lithium salt dissolved therein; and a sheet-made exterior packaging material 1 of 0.5 mm or less in thickness including a resin layer and accommodating the electrode group 2; wherein the nonaqueous solvent contains γ-butyrolactone from over 50 vol.% to under or equal to 95 vol.% of the total nonaqueous solvent.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a nonaqueous electrolyte rechargeable battery.
[0002]
[Description of the Prior Art] The rechargeable lithium-ion battery is commercialized as a nonaqueous electrolyte rechargeable battery for pocket devices, such as current and a cellular phone. Porous membrane is used for the organic solvent and separator with which this cell dissolved the graphite ingredient and the carbonaceous ingredient in lithium cobalt oxide ($LiCoO_2$) and a negative electrode, and dissolved lithium salt in the positive electrode at nonaqueous electrolyte. As a solvent of said electrolytic solution, the non-aqueous solvent of hypoviscosity and a low-boiling point is used.
[0003] For example, the mixed solvent which consists of propylene carbonate, ethylene carbonate, and gamma-butyrolactone is made into a subject, and the nonaqueous electrolyte rechargeable battery equipped with the electrolytic solution whose ratio of gamma-butyrolactone is ten to 50 volume [of the whole solvent] % is indicated by JP,4-14769,A. It aims at improving the low-temperature discharge property of a cylindrical shape nonaqueous electrolyte rechargeable battery in this official report.
[0004] By the way, it is requested that thickness of a cell is made thin with thin-shape-izing of a pocket device. For that, it is necessary to make thin thickness of the sheathing material which contains a positive electrode, a negative electrode, a separator, and nonaqueous electrolyte. However, the generation of gas of the equipped with the nonaqueous electrolyte containing the solvent whose content of the gamma-butyrolactone indicated by JP,4-14769,A mentioned above is ten to 50 volume % rechargeable lithium-ion battery increases from a negative electrode at the time of an initial charge, or the oxidative degradation of nonaqueous electrolyte produces [a positive electrode and nonaqueous electrolyte] it in response to the time of storing in an elevated temperature 60 degrees C or more, and the generation of gas breaks out. For this reason, if thickness of a sheathing material is made thin, a sheathing material will blister by this generation of gas, and the trouble of deforming will be produced. When a sheathing material deforms, a cell stops restoring to electronic equipment, and there is a possibility of causing incorrect actuation of electronic equipment.
[0005] On the other hand, the nonaqueous electrolyte rechargeable battery equipped with what dissolved hoe lithium fluoride ($LiBF_4$) in the solvent whose ratio of gamma-butyrolactone is 100 volume % as nonaqueous electrolyte is indicated by JP,11-97062,A. It aims at controlling that oxidative degradation of the positive electrode which contains a lithium cobalt multiple oxide as an active material is carried out by nonaqueous electrolyte in this official report.
[0006] However, the nonaqueous electrolyte which dissolved hoe lithium fluoride ($LiBF_4$) in the solvent whose ratio of the gamma-butyrolactone indicated by JP,11-97062,A is 100 volume % reacts with a negative electrode, and reduction decomposition tends to produce it. Consequently, since it becomes easy to produce current concentration in a negative electrode, a lithium metal deposits, or the impedance of a negative-electrode interface becomes high, the charge-and-discharge effectiveness of a negative electrode falls to a negative-electrode front face, and the fall of a charge-and-discharge cycle property is caused.
[0007] Moreover, in the nonaqueous electrolyte rechargeable battery, the further improvement of a high current discharge property and a charge-and-discharge cycle property is demanded.
[0008]
[Problem(s) to be Solved by the Invention] The purpose of this invention tends to offer the nonaqueous

electrolyte rechargeable battery which it stops that a sheathing material blisters and can be improved in a high current discharge property and a charge-and-discharge cycle property by controlling the generation of gas at the time of storing at an elevated temperature.

[0009]

[Means for Solving the Problem] The negative electrode which contains occlusion and the ingredient to emit for a positive electrode and a lithium ion according to this invention, It sinks into said electrode group. An electrode group equipped with the separator arranged between said positive electrode and said negative electrode; A non-aqueous solvent, Said electrode group is contained and sheathing-material; which the thickness containing a resin layer becomes from a sheet 0.5mm or less is provided. Nonaqueous electrolyte containing the lithium salt dissolved in said non-aqueous solvent; said non-aqueous solvent The nonaqueous electrolyte rechargeable battery which there are and contains gamma-butyrolactone below 95 volume % from 50 volume % of the whole non-aqueous solvent is offered. [many]

[0010] The negative electrode which contains occlusion and the ingredient to emit for a positive electrode and a lithium ion according to this invention, It sinks into said electrode group. An electrode group equipped with the separator arranged between said positive electrode and said negative electrode; A non-aqueous solvent, Nonaqueous electrolyte containing the lithium salt dissolved in said non-aqueous solvent; the thickness by which said electrode group is contained possesses 0.3mm or less sheathing-material;, and the nonaqueous electrolyte rechargeable battery with which there are many said non-aqueous solvents, and they contain gamma-butyrolactone below 95 volume % from 50 volume % of the whole non-aqueous solvent is offered.

[0011] The positive electrode which contains the positive-active-material layer supported by one side or both sides of a positive-electrode charge collector and said positive-electrode charge collector according to this invention, The negative electrode containing the negative-electrode active material layer which is supported by one side or both sides of a negative-electrode charge collector and said negative-electrode charge collector, and contains occlusion and the ingredient to emit for a lithium ion, It sinks into said electrode group. An electrode group equipped with the separator arranged between said positive electrode and said negative electrode; A non-aqueous solvent, Nonaqueous electrolyte containing the lithium salt dissolved in said non-aqueous solvent; Said electrode group is contained. Sheathing-material; which the thickness containing a resin layer becomes from a sheet 0.5mm or less is provided. Voidage of said positive-active-material layer is made low compared with the voidage of said negative-electrode active material layer, the thickness of said positive-active-material layer is 10-100 micrometers, and the nonaqueous electrolyte rechargeable battery with which said non-aqueous solvent contains gamma-butyrolactone below 95 volume % more than 40 volume % of the whole non-aqueous solvent is offered.

[0012] The positive electrode which contains the positive-active-material layer supported by one side or both sides of a positive-electrode charge collector and said positive-electrode charge collector according to this invention, The negative electrode containing the negative-electrode active material layer which is supported by one side or both sides of a negative-electrode charge collector and said negative-electrode charge collector, and contains occlusion and the ingredient to emit for a lithium ion, It sinks into said electrode group. An electrode group equipped with the separator arranged between said positive electrode and said negative electrode; A non-aqueous solvent, Nonaqueous electrolyte containing the lithium salt dissolved in said non-aqueous solvent; The thickness by which said electrode group is contained possesses 0.3mm or less sheathing-material;. Voidage of said positive-active-material layer is made low compared with the voidage of said negative-electrode active material layer, the thickness of said positive-active-material layer is 10-100 micrometers, and the nonaqueous electrolyte rechargeable battery with which said non-aqueous solvent contains gamma-butyrolactone below 95 volume % more than 40 volume % of the whole non-aqueous solvent is offered.

[0013]

[Embodiment of the Invention] Nonaqueous electrolyte which it sinks into the electrode group; aforementioned electrode group equipped with the separator with which the 1st nonaqueous electrolyte rechargeable battery concerning this invention is arranged in a positive electrode and a lithium ion between the negative electrode containing occlusion and the ingredient to emit, and said positive electrode and said negative electrode, and contains a non-aqueous solvent and the lithium salt dissolved in said non-aqueous solvent; sheathing-material; by which said electrode group is contained is provided. Moreover, from 50 volume % of the whole non-aqueous solvent, there are many said non-aqueous solvents and they contain gamma-butyrolactone below 95 volume %.

[0014] Although said positive electrode, said negative electrode, and said separator do not need to be unified, as for this rechargeable battery, it is desirable to be unified on conditions which are explained to the following (a) or (b).
[0015] (a) While said positive electrode and said separator are unified with the macromolecule which has the adhesive property which exists in a part of these boundaries [at least], said negative electrode and said separator are unified with the macromolecule which has the adhesive property which exists in a part of these boundaries [at least]. While being unified with the macromolecule which has the adhesive property with which these interior and boundaries are especially dotted with said positive electrode and said separator, it is desirable to be unified with the macromolecule which has the adhesive property with which these interior and boundaries are dotted with said negative electrode and said separator.
[0016] (b) Said positive electrode, said negative electrode, and said separator are unified by carrying out heat curing of the binder contained in said positive electrode and said negative electrode.
[0017] By making it this configuration of (a) or (b), bulging of a sheathing material can be reduced further.
[0018] Moreover, as for said rechargeable battery, it is desirable for the product of cell capacity (Ah) and 1kHz cell internal impedance (mohms) to be below 110m ohm-Ah more than 10mohm and Ah. By making the product of capacity and an impedance into said within the limits, a high current discharge property and a charge-and-discharge cycle property can be improved more. Here, cell capacity is the discharge capacity at the time of discharging by nominal capacity or 0.2C. More desirable range is below 60mohm and Ah more than 20mohm and Ah.
[0019] making the product of cell capacity and an impedance below into 110m ohm-Ah more than 10m ohm-Ah -- for example, it is possible by the manufacture approach of of the manufacture approach of (I) mentioned later, or (II) mentioned later. However, in (I), more than 10m ohm-Ah, the product of cell capacity and an impedance sets up distribution of the addition of an adhesive macromolecule and an adhesive macromolecule, and initial charge conditions so that it may become below 110m ohm-Ah. Moreover, in (II), more than 10m ohm-Ah, the product of cell capacity and an impedance sets up the temperature, press **, and the initial charge conditions at the time of fabricating an electrode group so that it may become below 110m ohm-Ah.
[0020] A nonaqueous electrolyte rechargeable battery equipped with the electrode group which satisfies hereafter (a) mentioned above is explained.
[0021] 1) **** -- this positive electrode has the structure where the positive-electrode layer containing an active material was supported by one side or both sides of a charge collector.
[0022] Said positive-electrode layer contains positive active material and an electric conduction agent. Moreover, said positive-electrode layer contains the binder which binds positive active material apart from the macromolecule which has an adhesive property.
[0023] As said positive active material, chalcogen compounds, such as various oxide, for example, a manganese dioxide, a lithium manganese multiple oxide, a lithium content nickel oxide, lithium content cobalt oxide, lithium content nickel cobalt oxide, a lithium content ferric acid ghost, a banazin san ghost containing a lithium, and 2 titanium sulfides, molybdenum disulfide, etc. can be mentioned. Especially, when lithium content cobalt oxide (for example, LiCoO2), lithium content nickel cobalt oxide (for example, LiNi0.8Co 0.2O2), and a lithium manganese multiple oxide (for example, LiMn 2O4 and LiMnO2) are used, since the high voltage is obtained, it is desirable.
[0024] As said electric conduction agent, acetylene black, carbon black, a graphite, etc. can be mentioned, for example.
[0025] Said binder has the function which is made to hold an active material to a charge collector, and connects active materials. As said binder, polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVdF), an ethylene-propylene-diene copolymer (EPDM), a styrene butadiene rubber (SBR), etc. can be used, for example.
[0026] the blending ratio of coal of said positive active material, an electric conduction agent, and a binder -- 80 - 95 % of the weight of positive active material, and an electric conduction agent -- it is desirable to make it the range of 2 - 7 % of the weight of binders three to 20% of the weight.
[0027] As said charge collector, the conductive substrate of a vesicular structure or a nonporous conductive substrate can be used. These conductivity substrate can be formed from aluminum, stainless steel, or nickel.
[0028] Especially, a hole with a diameter of 3mm or less is 2 10cm. It is desirable to use the conductive substrate which has the two-dimensional vesicular structure which exists at a rate of one or more hits. That is,

when the diameter of the hole by which opening was carried out to the conductive substrate becomes larger than 3mm, there is a possibility that sufficient positive-electrode reinforcement may no longer be obtained. On the other hand, if the abundance of a hole with a diameter of 3mm or less becomes less than said range, since it will become difficult to make nonaqueous electrolyte permeate homogeneity at an electrode group, there is a possibility that sufficient charge-and-discharge cycle property may no longer be acquired. As for the diameter of a hole, it is more desirable to make it the range of 0.1-1mm. Moreover, as for the abundance of a hole, it is more desirable that 10-20 range per two costs 10cm.

[0029] A hole with a diameter of 3mm or less mentioned above is 2 10cm. As for the conductive substrate which has the two-dimensional vesicular structure which exists at a rate of one or more hits, it is desirable to make thickness into the range of 15-100 micrometers. When thickness is set to less than 15 micrometers, there is a possibility that sufficient positive-electrode reinforcement may no longer be obtained. On the other hand, when thickness exceeds 100 micrometers, the thickness of cell weight and an electrode group increases, and there is a possibility that it may become difficult to make high enough the weight energy density and volume energy density of a thin rechargeable battery. The more desirable range of thickness is 30-80 micrometers.

[0030] 2) The negative-electrode aforementioned negative electrode has the structure where the negative-electrode layer was supported by one side or both sides of a charge collector.

[0031] Said negative-electrode layer contains occlusion and the carbonaceous object to emit for a lithium ion. Moreover, said negative-electrode layer contains the binder which binds a negative-electrode ingredient apart from the macromolecule which has an adhesive property.

[0032] A graphite ingredient or a carbonaceous ingredient obtained as said carbonaceous object by heat-treating at 500-3000 degrees C to graphite ingredients, such as a graphite, corks, a carbon fiber, and spherical carbon, or a carbonaceous ingredient, thermosetting resin, an isotropic pitch, a mesophase pitch, a mesophase pitch based carbon fiber, a mesophase microsphere, etc. (a mesophase pitch based carbon fiber becoming high and having capacity and an especially desirable charge-and-discharge cycle property) can be mentioned. Especially, it is obtained by making temperature of said heat treatment into 2000 degrees C or more, and is the spacing d002 of a field (002). It is desirable to use the graphite ingredient which has the graphite crystal which is 0.340nm or less. The nonaqueous electrolyte rechargeable battery equipped with the negative electrode which contains such a graphite ingredient as a carbonaceous object can improve sharply cell capacity and a high current discharge property. Said spacing d002 It is still more desirable that it is 0.336nm or less.

[0033] As said binder, polytetrafluoroethylene (PTFE), polyvinylidene fluoride (PVdF), an ethylene-propylene-diene copolymer (EPDM), styrene-PUTAJI en rubber (SBR), a carboxymethyl cellulose (CMC), etc. can be used, for example.

[0034] As for the blending ratio of coal of said carbonaceous object and said binder, it is desirable that it is the range of 90 - 98 % of the weight of carbonaceous objects and 2 - 20 % of the weight of binders.

[0035] As said charge collector, the conductive substrate of a vesicular structure or a nonporous conductive substrate can be used. These conductivity substrate can be formed from copper, stainless steel, or nickel.

[0036] Especially, a hole with a diameter of 3mm or less is 2 10cm. It is desirable to use the conductive substrate which has the two-dimensional vesicular structure which exists at a rate of one or more hits. That is, when the diameter of the hole of a conductive substrate becomes larger than 3mm, there is a possibility that sufficient negative-electrode reinforcement may no longer be obtained. On the other hand, if the abundance of a hole with a diameter of 3mm or less becomes less than said range, since it will become difficult to make nonaqueous electrolyte permeate homogeneity at an electrode group, there is a possibility that sufficient charge-and-discharge cycle property may no longer be acquired. As for the diameter of a hole, it is more desirable to make it the range of 0.1-1mm. Moreover, the abundance of a hole is 2 10cm. It is more desirable to make it the range of 10-20 hits.

[0037] A hole with a diameter of 3mm or less mentioned above is 2 10cm. As for the conductive substrate which has the two-dimensional vesicular structure which exists at a rate of one or more hits, it is desirable to make thickness into the range of 10-50 micrometers. When thickness is set to less than 10 micrometers, there is a possibility that sufficient negative-electrode reinforcement may no longer be obtained. On the other hand, when thickness exceeds 50 micrometers, the thickness of cell weight and an electrode group increases, and there is a possibility that it may become difficult to make high enough the weight energy density and volume energy density of a thin rechargeable battery.

[0038] although said negative-electrode layer contains occlusion and the carbon matter to emit for the lithium ion mentioned above -- others -- metals, such as aluminum, magnesium, tin, and a silicon, a metallic oxide, and metallic sulfide -- or the metallic compounds chosen from a metal nitride and a lithium alloy may be included.
[0039] As said metallic oxide, a stannic-acid ghost, silicon oxide, a lithium titanic-acid ghost, a niobic acid ghost, a tungstic-acid ghost, etc. can be mentioned, for example.
[0040] As said metallic sulfide, a tin sulfide, a titanium sulfide, etc. can be mentioned, for example.
[0041] As said metal nitride, a lithium cobalt nitride, a lithium iron nitride, a lithium manganese nitride, etc. can be mentioned, for example.
[0042] As said lithium alloy, a lithium aluminium alloy, a lithium tin alloy, a lithium lead alloy, a lithium silicon alloy, etc. can be mentioned, for example.
[0043] 3) The separator of separator ** is formed from a porosity sheet.
[0044] As said porosity sheet, a porosity film or a nonwoven fabric can be used, for example. As for said porosity sheet, it is desirable to consist of at least one kind of ingredient chosen from polyolefine and a cellulose. As said polyolefine, polyethylene and polypropylene can be mentioned, for example. Since the porosity film which consists of polyethylene, polypropylene, or both especially can improve the safety of a rechargeable battery, it is desirable.
[0045] As for the thickness of said porosity sheet, it is desirable to make it 30 micrometers or less. When thickness exceeds 30 micrometers, there is a possibility that the distance between forward negative electrodes may become large, and internal resistance may become large. Moreover, as for the lower limit of thickness, it is desirable to make it 5 micrometers. When thickness is set to less than 5 micrometers, the reinforcement of a separator falls remarkably and there is a possibility of becoming easy to produce internal short-circuit. As for the upper limit of thickness, it is more desirable to make it 25 micrometers, and, as for a lower limit, it is more desirable to make it 10 micrometers.
[0046] As for said porosity sheet, it is desirable that it is 20% or less about 120 degrees C and the rate of a heat shrink in 1 hour. When said rate of a heat shrink exceeds 20%, there is a possibility that it may become difficult to make bond strength of a forward negative electrode and a separator into sufficient thing. As for said rate of a heat shrink, it is more desirable to make it to 15% or less.
[0047] As for said porosity sheet, it is desirable that it is the range whose porosity is 30 - 60%. This is based on the following reasons. When porosity is made less than 30%, there is a possibility that it may become difficult to acquire high electrolytic-solution holdout in a separator. On the other hand, when porosity exceeds 60%, there is a possibility that it may become impossible to obtain sufficient separator reinforcement. The more desirable range of porosity is 35 - 50%.
[0048] For said porosity sheet, air permeability is 600 second / 100cm3. It is desirable that it is the following. Air permeability means the time amount (second) taken for the air of 3 to penetrate a porosity sheet 100cm. Air transmission is 600 second / 100cm3. When it exceeds, there is a possibility that it may become difficult to obtain high lithium ion mobility in a separator. Moreover, the lower limit of air permeability is 100 second / 100cm3. Carrying out is desirable. It is air permeability 100 second / 100cm3 It is because there is a possibility that it may become impossible to obtain sufficient separator reinforcement when it is made the following. the upper limit of air permeability -- 500 second / 100cm3 the upper limit with more desirable still more desirable carrying out -- 400 second / 100cm3 it is . Moreover, a lower limit is 150 second / 100cm3. Carrying out is more desirable.
[0049] 4) The nonaqueous electrolyte aforementioned nonaqueous electrolyte is what dissolved lithium salt in the mixed non-aqueous solvent which makes gamma-butyrolactone (BL) a subject, and there are more presentation ratios of BL than 50 volume % of the mixed whole non-aqueous solvent, and they are below 95 volume %. It is become easy to generate gas at the time of an elevated temperature that a ratio is below 50 volume %. Moreover, since the ratio of annular carbonate becomes high relatively when a mixed non-aqueous solvent is a thing containing BL and annular carbonate, solvent viscosity becomes high and the conductivity of nonaqueous electrolyte falls. Consequently, a charge-and-discharge cycle property, a high current discharge property, and the discharge property under the low-temperature environment near -20 degree C fall. On the other hand, if a ratio exceeds 95 volume %, since the reaction of a negative electrode and BL will arise, a charge-and-discharge cycle property falls. That is, if a negative electrode (for example, thing containing the carbonaceous object which carries out occlusion emission of the lithium ion), and BL react and reduction

decomposition of nonaqueous electrolyte arises, the coat which checks a charge-and-discharge reaction on the surface of a negative electrode will be formed. Consequently, since it becomes easy to produce current concentration in a negative electrode, a lithium metal deposits, or the impedance of a negative-electrode interface becomes high, the charge-and-discharge effectiveness of a negative electrode falls to a negative-electrode front face, and the fall of a charge-and-discharge cycle property is caused. The more desirable range is below 95 volume % more than 60 volume %. While being able to make higher effectiveness which controls the generation of gas at the time of elevated-temperature storage by making it this range, the discharge capacity under the low-temperature environment near -20 degree C can be improved more. Furthermore, the desirable range is below 90 volume % more than 65 volume %.
[0050] As a solvent mixed with BL, it is desirable at the point that annular carbonate raises the charge-and-discharge effectiveness of a negative electrode.
[0051] As said annular carbonate, (propylene carbonate PC) (ethylene carbonate EC) (vinylene carbonate VC) truffe ROROPURO pyrene carbonate (TFPC) etc. is desirable. If EC is used as a solvent especially mixed with BL, a charge-and-discharge cycle property and a high current discharge property can be improved sharply. Moreover, it is desirable at the point which raises a charge-and-discharge cycle property as it is the mixed solvent of the 3rd solvent and EC which are chosen from the group which consists of PC, VC, TFPC, diethyl carbonate (DEC), methylethyl carbonate (MEC), and an aromatic compound as other solvents mixed with BL, and which consist of a kind at least.
[0052] A hypoviscosity solvent may also be included below 20 volume % from a viewpoint in which solvent viscosity is furthermore reduced. As a hypoviscosity solvent, for example, chain-like carbonate, the chain-like ether, cyclic ether, etc. are mentioned.
[0053] The more desirable presentation of the non-aqueous solvent concerning this invention is BL, EC, and PC and VC. [BL, PC, BL and EC, DEC, BL and EC MEC, BL and EC, MEC, VC and BL, EC, VC and BL, PC and VC, or] [BL, EC,] As for the rate of a volume ratio of EC, at this time, it is desirable to consider as five to 40 volume %. This is based on the following reasons. Since there is a possibility that it may become difficult to cover a negative-electrode front face precisely by the protective coat when the ratio of EC is made under into 5 volume %, the reaction of a negative electrode and BL may arise and it may become difficult to fully improve a charge-and-discharge cycle property. On the other hand, since there is a possibility that the viscosity of nonaqueous electrolyte may become high and ionic conductivity may fall when the ratio of EC exceeds 40 volume %, it may become difficult to fully improve a charge-and-discharge cycle property, a high current discharge property, and a low-temperature discharge property. The still more desirable range of the ratio of EC is ten to 35 volume %. Moreover, the solvent which consists of at least one kind chosen from DEC, MEC, PC, and VC forms a precise protective coat on the surface of a negative electrode, and makes the operation which reduces the interface impedance of a negative electrode. Especially the addition of this solvent is not limited and is set as an amount which this operation produces. However, when the ratio of at least one kind of solvent chosen from DEC, MEC, PC, and VC in a non-aqueous solvent exceeds 10 volume %, there is a possibility that fully controlling may become difficult about nonaqueous electrolyte carrying out oxidative degradation under hot environments, or the viscosity of nonaqueous electrolyte may become high, and ion conductivity may fall. For this reason, as for the rate of a volume ratio of at least one kind of solvent chosen from DEC, MEC, PC, and VC in a non-aqueous solvent, it is desirable to carry out to below 10 volume %. Furthermore, the desirable rate of a volume ratio is below 2 volume %. Moreover, the lower limit with desirable still more desirable making the lower limit of the rate of a volume ratio into 0.001 volume % is 0.05 volume %.
[0054] Especially and the non-aqueous solvent containing BL, EC, and VC below 95 volume % is desirable than 50 volume %. Since the nonaqueous electrolyte rechargeable battery equipped with the nonaqueous electrolyte containing this non-aqueous solvent and the negative electrode containing the carbonaceous object which carries out occlusion emission of the lithium ion can control that a metal lithium deposits in a negative electrode while being able to reduce the impedance of the interface of a negative electrode sharply, it can improve the charge-and-discharge effectiveness of a negative electrode. Consequently, realizing the outstanding high current discharge property and a longevity life, the generation of gas at the time of elevated-temperature storage can be controlled, and deformation of a sheathing material can be suppressed. Thus, it is guessed that it is what is depended on an operation which is explained below that a negative-electrode property is improved. In said rechargeable battery, the protective film by EC is formed in the front face of said negative electrode, and it

is alike, in addition the thin and precise coat by VC is formed. Consequently, since the reaction of BL and a negative electrode is suppressed further, it is thought that the fall of an impedance and deposit prevention of a metal lithium are attained.

[0055] Moreover, although it has the presentation mentioned above as a non-aqueous solvent, instead, and the thing containing BL, EC, and the aromatic compound below 95 volume % may be used than 50 volume %. As said aromatic compound, at least one kind chosen from benzene, toluene, a xylene, a biphenyl, and a terphenyl can be mentioned, for example. EC can adhere on the surface of a negative electrode (for example, thing containing the carbonaceous object which carries out occlusion emission of the lithium ion), can form a protective coat, and can control the reaction of a negative electrode and BL. As for the rate of a volume ratio of EC, at this time, it is desirable to consider as five to 40 volume % for the reason same with having mentioned above. Moreover, the still more desirable range of the ratio of EC is ten to 35 volume %. On the other hand, since it is easy to stick on the surface of a negative electrode (for example, thing containing the carbonaceous object which carries out occlusion emission of the lithium ion) to the benzene ring of said aromatic compound, it can control the reaction of a negative electrode and BL. Therefore, and since the nonaqueous electrolyte containing the non-aqueous solvent containing BL, EC, and the aromatic compound below 95 volume % can fully suppress the reaction of a negative electrode and BL, it can improve the charge-and-discharge cycle property of a rechargeable battery than 50 volume %. As for such a non-aqueous solvent, it is desirable that the solvent which consists of at least one kind chosen from DEC, MEC, PC, TFPC, and VC further is included. Since the reaction of a negative electrode and BL can be further controlled by adding the solvent which consists of at least one kind chosen from DEC, MEC, PC, TFPC, and VC, a charge-and-discharge cycle property can be improved further. Especially, VC is desirable. Especially the addition of the 3rd solvent which consists of at least one kind chosen from an aromatic compound, DEC, MEC and PC, TFPC, and VC is not limited, and is set as an amount which this operation produces. However, when the ratio of said 3rd solvent in a non-aqueous solvent exceeds 10 volume %, there is a possibility that fully controlling may become difficult about nonaqueous electrolyte carrying out oxidative degradation under hot environments, or the viscosity of nonaqueous electrolyte may become high, and ion conductivity may fall. For this reason, as for the rate of a volume ratio of said 3rd solvent in a non-aqueous solvent, it is desirable to carry out to below 10 volume %. Furthermore, the desirable rate of a volume ratio is below 2 volume %. Moreover, the lower limit with desirable still more desirable making the lower limit of the rate of a volume ratio into 0.001 volume % is 0.05 volume %.

[0056] As an electrolyte contained in said nonaqueous electrolyte, it is lithium perchlorate ($LiClO_4$), 6 phosphorus-fluoride acid lithium ($LiPF_6$), hoe lithium fluoride ($LiBF_4$), 6 fluoride arsenic lithium ($LiAsF_6$), trifluoro meta-sulfonic-acid lithium ($LiCF_3SO_3$), and bis-trifluoromethylsulfonyl imide lithium [(lithium salt (electrolyte), such as $LiN(CF_3SO_2)_2$], is mentioned.), for example. It is $LiPF_6$ especially. Or $LiBF_4$ Using is desirable.

[0057] As for the amount of dissolutions to said non-aqueous solvent of said electrolyte, it is desirable to carry out in 0.5-2.0 mols/l.

[0058] As for the amount of said nonaqueous electrolyte, it is desirable to make it per [0.2-0.6g] cell unit capacity 100mAh. This is based on the following reasons. When the amount of nonaqueous electrolysis is set to 0.2g / less than 100 mAhs, there is a possibility that it may become impossible to fully maintain the ionic conductivity of a positive electrode and a negative electrode. On the other hand, when the amount of nonaqueous electrolyte exceeds 0.6g/100mAh, there is a possibility that the amount of electrolytic solutions may become abundant and the closure by the sheathing material made from a film may become difficult. The more desirable range of the amount of nonaqueous electrolyte is 0.4-0.55g/100mAh.

[0059] 5) As for the macromolecule which has the macromolecule aforementioned adhesive property which has an adhesive property, it is desirable that it is what can maintain a high adhesive property where nonaqueous electrolyte is held. Furthermore, when this giant molecule has high lithium ion conductivity, in addition, it is desirable. Specifically, a polyacrylonitrile (PAN), polyacrylate (PMMA), polyvinylidene fluoride (PVdF), a polyvinyl chloride (PVC), or polyethylene oxide (PEO) can be mentioned. Especially, polyvinylidene fluoride is desirable. Polyvinylidene fluoride can hold nonaqueous electrolyte, and since it will produce gelation in part if it contains nonaqueous electrolyte, it can improve ionic conductivity more.

[0060] As for the macromolecule which has said adhesive property, it is desirable to take the vesicular structure which has a detailed hole in a positive electrode, a negative electrode, and the opening of a separator. The

macromolecule which has the adhesive property which has a vesicular structure can hold nonaqueous electrolyte.
[0061] As for the total amount of the macromolecule which has the adhesive property included in said cell, it is desirable to make it 0.1-6mg per cell capacity 100mAh. This is based on the following reasons. When the total amount of the macromolecule which has an adhesive property is set to less than 0.1mg per cell capacity 100mAh, there is a possibility that it may become difficult to fully raise the adhesion of a positive electrode, a separator, and a negative electrode. On the other hand, when said total amount exceeds 6mg per cell capacity 100mAh, there is a possibility of causing the fall of the lithium ion conductivity of a rechargeable battery and the rise of internal resistance, and there is a possibility that it may become difficult to improve discharge capacity, a high current discharge property, and a charge-and-discharge cycle property. The more desirable range of the total amount of the macromolecule which has an adhesive property is 0.2-1mg per cell capacity 100mAh.
[0062] 6) The 2nd sheathing material 0.3mm or less is used for the sheathing material of ******** for the 1st sheathing material of the product [thickness / containing a resin layer] made from a sheet 0.5mm or less, and thickness. Since it has the flexibility (flexibility) of what can make energy density per cell weight high since it is lightweight, these 1st and 2nd sheathing materials are easy to deform by the gas which occurs from an electrode group or nonaqueous electrolyte.
[0063] The resin layer contained in the 1st sheathing material can be formed from polyethylene, polypropylene, etc. Specifically, said 1st sheathing material consists of a sheet with which the metal layer and the protective layer arranged to both sides of said metal layer were unified. Said metal layer makes the role which intercepts moisture. Said metal layer can mention aluminum, stainless steel, iron, copper, nickel, etc. Aluminum with the function it is lightweight and high especially, which intercepts moisture is desirable. Although said metal layer may be formed from one kind of metal, it may be formed from the thing which made two or more kinds of metal layers unify. The protective layer which touches the exterior between said two protective layers makes the role which prevents damage on said metal layer. This external protective layer is formed from one kind of resin layer, or two or more kinds of resin layers. On the other hand, an internal protective layer bears the role which prevents that said metal layer is corroded by nonaqueous electrolyte. This internal protective layer is formed from one kind of resin layer, or two or more kinds of resin layers. Moreover, thermal melting arrival nature resin can be arranged on the front face of this internal protective layer.
[0064] If the thickness of said 1st sheathing material exceeds 0.5mm, the capacity per weight of a cell will fall. It is 0.25mm or less to make it 0.3mm or less desirable still more preferably, and the thickness of the 1st sheathing material is 0.15mm or less most preferably. moreover -- if thickness is thinner than 0.05mm -- deformation -- it becomes easy to damage. For this reason, as for the lower limit of thickness, it is desirable to make it 0.05mm. Furthermore, a desirable lower limit is 0.08mm and the most desirable range is 0.1mm.
[0065] A metal can or the film which has the function which intercepts moisture can be used for said 2nd sheathing material. Said metal can can be formed from iron, stainless steel, and aluminum. On the other hand, as said film, the laminate film containing a metal layer and the synthetic-resin layer which has the flexibility formed in said a part of metal layer [at least] can be mentioned, for example. Said metal layer can mention aluminum, stainless steel, iron, copper, nickel, etc. Aluminum with the function it is lightweight and high especially, which intercepts moisture is desirable. Moreover, as said synthetic resin, polyethylene, polypropylene, etc. can be mentioned, for example.
[0066] If the thickness of said 2nd sheathing material is thicker than 0.3mm, the effectiveness of thin-shape-izing will be small, that is, it will become difficult to make weight energy density high enough. The range where it is desirable still more desirable setting thickness of said 2nd sheathing material to 0.25mm or less is 0.15mm or less. moreover -- if thickness is thinner than 0.05mm -- deformation -- it becomes easy to damage. For this reason, as for the lower limit of thickness, it is desirable to make it 0.05mm. Furthermore, a desirable lower limit is 0.08mm and the most desirable range is 0.1mm. As for especially the thickness of said 2nd sheathing material, it is desirable that it is within the limits of 0.05-0.3mm. The still more desirable range is 0.08-0.15mm.
[0067] The thickness of a sheathing material is measured by the approach explained below. That is, in the field except the closure section of a sheathing material, mutually, it separates 1cm or more, and three existing points are chosen as arbitration, the thickness of each point is measured, and the average is computed, and let this

value be the thickness of a sheathing material. In addition, when the foreign matter (for example, resin) has adhered to the front face of said sheathing material, thickness is measured after removing this foreign matter. For example, measurement of thickness is performed after removing PVdF by wiping off the front face of said sheathing material with a dimethylformamide solution, when PVdF has adhered to the front face of said sheathing material.
[0068] When using said sheathing material made from a film, it is desirable for said electrode group to have pasted the inside of said sheathing material by the glue line formed in a part of the front face [at least]. If it is made such a configuration, since said sheathing material is fixable to the front face of said electrode group, it can suppress that the electrolytic solution permeates between an electrode group and a sheathing material.
[0069] The thin rechargeable lithium-ion battery which is an example of this nonaqueous electrolyte rechargeable battery is explained to a detail with reference to drawing 1 and drawing 2 .
[0070] The sectional view showing the thin rechargeable lithium-ion battery whose drawing 1 is an example of the 1st [concerning this invention] nonaqueous electrolyte rechargeable battery, the expanded sectional view in which drawing 2 shows the A section of drawing 1 , and drawing 3 are the mimetic diagrams showing near the boundary of the positive-electrode layer in the rechargeable battery of drawing 1 , a separator, and a negative-electrode layer.
[0071] As shown in drawing 1 , the sheathing material 1 which consists of a film is surrounding the electrode group 2. Said electrode group 2 has the structure where the laminated material which consists of a positive electrode, a separator, and a negative electrode was wound around the flat configuration. As said laminated material is shown in drawing 2 A separator 3, the positive-electrode layer 4 and the positive-electrode charge collector 5, the positive electrode 12 equipped with the positive-electrode layer 4, a separator 3 and the negative-electrode layer 6, the negative-electrode charge collector 7, the negative electrode 13 equipped with the negative-electrode layer 6, a separator 3 and the positive-electrode layer 4, the positive-electrode charge collector 5, and a positive electrode 12, a separator 3 equipped with the positive-electrode layer 4, (from the drawing bottom) The negative electrode 13 equipped with the negative-electrode layer 6 and the negative-electrode charge collector 7 carried out the laminating to this sequence. As for said electrode group 2, said negative-electrode charge collector 7 is located in the outermost layer. As for the front face of said electrode group 2, jointing 8 exists. The inside of said sheathing material 1 is pasted up on said jointing 8. As shown in drawing 3 , the macromolecule 9 which has an adhesive property is held in the opening of the positive-electrode layer 4, a separator 3, and the negative-electrode layer 6, respectively. The positive electrode 12 and the separator 3 are pasted up with the macromolecule 9 which has the adhesive property with which the interior and these boundaries of the positive-electrode layer 4 and a separator 3 are dotted. On the other hand, the negative electrode 13 and the separator 3 are pasted up with the macromolecule 9 which has the adhesive property with which the interior and these boundaries of the negative-electrode layer 6 and a separator 3 are dotted. Nonaqueous electrolyte sinks into said electrode group 2 in said sheathing material 1. The end was connected to said positive-electrode charge collector 5 of said electrode group 2, and, as for the band-like positive-electrode lead 10, the other end has extended from said sheathing material 1. On the other hand, the end was connected to said negative-electrode charge collector 7 of said electrode group 2, and, as for the band-like negative-electrode lead 11, the other end has extended from said sheathing material 1.
[0072] In addition, in drawing 1 mentioned above, although jointing 8 was formed in the whole front face of the electrode group 2, jointing 8 may be formed in a part of electrode group 2. When forming jointing 8 in a part of electrode group 2, it is desirable to form in the field which is equivalent to the outermost periphery of an electrode group at least. Moreover, there may not be jointing 8.
[0073] A nonaqueous electrolyte rechargeable battery equipped with the electrode group which satisfies this condition of (a) mentioned above is manufactured for example, by the (I) approach explained below. However, if the manufacture approach of the nonaqueous electrolyte rechargeable battery concerning this invention is in the range of this invention, it will not be limited to the following gestalten.
[0074] A porosity sheet is made to intervene as a separator between the <manufacture approach (I)> (1st process) positive electrode and a negative electrode, and an electrode group is produced.
[0075] After said electrode group winds a positive electrode and a negative electrode around a curled form through macromolecule the separator which is not held [which has an adhesive property in the meantime] or winds them around a curled form, it is desirable to compress in the direction of a path or to produce a positive

electrode and a negative electrode by bending an adhesive property two or more times in the meantime through macromolecule the non-held separator which it has. It can prevent that said solution permeates the boundary of a positive electrode and a separator, and the whole boundary of a negative electrode and a separator, making the solution of the macromolecule which has an adhesive property in a positive electrode, a negative electrode, and a separator permeate in the 2nd process mentioned later, when it produces by such approach. Consequently, while it becomes possible for you to make it dotted with the macromolecule which has an adhesive property in a positive electrode, a negative electrode, and a separator, the boundary of a positive electrode and a separator and the boundary of a negative electrode and a separator can be made dotted with the macromolecule which has an adhesive property.

[0076] Said positive electrode suspends an electric conduction agent and a binder in positive active material at a suitable solvent, and is produced by applying this suspended solid to a charge collector, drying, and making it the shape of sheet metal. The column of (1) positive electrode mentioned above having explained as said positive active material, an electric conduction agent, a binder, and a charge collector and the same thing can be mentioned.

[0077] Said negative electrode applies the suspended solid which kneaded the lithium ion under existence of a solvent and was obtained [lithium ion] in occlusion, the carbonaceous object to emit, and the binder to a charge collector, and after drying, it is produced by pressing or 2 - 5 times multistage story pressing once by the desired pressure.

[0078] The column of (2) negative electrodes mentioned above having explained as said carbonaceous object, a binder, and a charge collector and the same thing can be mentioned.

[0079] The column of (3) separators mentioned above having explained as a porosity sheet of said separator and the same thing can be used.

[0080] (The 2nd process) In the sheathing material processed into saccate, said electrode group is contained so that a laminating side may be in sight from opening. The solution obtained by dissolving the macromolecule which has an adhesive property in a solvent is poured into the electrode group in said sheathing material from opening, and said solution is infiltrated into said electrode group.

[0081] Said column of (6) sheathing materials mentioned above if the sheathing material's was carried out having explained, and the same thing can be mentioned.

[0082] The column of a macromolecule which has the adhesive property of (5) mentioned above as a macromolecule which has said adhesive property having explained, and the same thing can be mentioned. Especially, PVdF is desirable.

[0083] It is desirable for the boiling point to use an organic solvent 200 degrees C or less for said solvent. this organic solvent -- carrying out -- for example, dimethyl formamide (153 degrees C of boiling points) can be mentioned. When the boiling point of an organic solvent exceeded 200 degrees C and temperature of the vacuum drying mentioned later is made into 100 degrees C or less, there is a possibility that the drying time may start for a long time. Moreover, as for the lower limit of the boiling point of an organic solvent, it is desirable to make it 50 degrees C. When the boiling point of an organic solvent is made into less than 50 degrees C, while pouring said solution into the electrode group, a possibility that said organic solvent may evaporate is. As for the upper limit of the boiling point, it is still more desirable to make it 180 degrees C, and, as for the lower limit of the boiling point, it is still more desirable to make it 100 degrees C.

[0084] As for the concentration of the macromolecule which has an adhesive property in said solution, it is desirable to make it 0.05 - 2.5% of the weight of the range. This is based on the following reasons. When said concentration is carried out to less than 0.05% of the weight, there is a possibility that it may become difficult to paste up a forward negative electrode and a separator by sufficient reinforcement. On the other hand, when said concentration exceeds 2.5 % of the weight, there is a possibility that it may become difficult to obtain sufficient porosity which can hold nonaqueous electrolyte, and the interface impedance of an electrode may become remarkably large. Increase of an interface impedance reduces capacity and a high current discharge property sharply. The more desirable range of concentration is 0.1 - 1.5 % of the weight.

[0085] When the concentration of the macromolecule which has the adhesive property of said solution is 0.05 - 2.5 % of the weight, as for the injection rate of said solution, it is desirable to make it the range which is 0.1-2ml per cell capacity 100mAh. This is based on the following reasons. When said injection rate is set to less than 0.1ml, there is a possibility that it may become difficult to fully raise the adhesion of a positive electrode, a

negative electrode, and a separator. On the other hand, when said injection rate exceeds 2ml, there is a possibility of causing the fall of the lithium ion conductivity of a rechargeable battery and the rise of internal resistance, and there is a possibility that it may become difficult to improve discharge capacity, a high current discharge property, and a charge-and-discharge cycle property. The more desirable range of said injection rate is 0.15-1ml per cell capacity 100mAh.
[0086] (The 3rd process) The solvent in said solution is evaporated and the macromolecule which has an adhesive property in said positive electrode, a negative electrode, and the opening of a separator is made to exist by performing a vacuum drying to said electrode group. While pasting up with the macromolecule which has the adhesive property with which these interior and boundaries are dotted with said positive electrode and said separator according to this process, it pastes up with the macromolecule which has the adhesive property with which these interior and boundaries are dotted with said negative electrode and said separator. Moreover, the moisture contained by this vacuum drying in said electrode group is removable to coincidence.
[0087] In addition, said electrode group permits that the solvent of a minute amount is included.
[0088] As for said vacuum drying, it is desirable to carry out below 100 degrees C. This is based on the following reasons. When the temperature of a vacuum drying exceeds 100 degrees C, there is a possibility that said separator may carry out a heat shrink sharply. If a heat shrink becomes large, since a separator will curve, it becomes difficult to paste up a positive electrode, a negative electrode, and a separator firmly. Moreover, when using the porosity film containing polyethylene or polypropylene as a separator, it is easy to produce the heat shrink mentioned above notably. Although the heat shrink of a separator can be controlled so that the temperature of a vacuum drying becomes low, when temperature of a vacuum drying is made into less than 40 degrees C, there is a possibility that it may become difficult to fully evaporate a solvent. For this reason, as for vacuum-drying temperature, it is more desirable to make it 40-100 degrees C.
[0089] (The 4th process) After pouring nonaqueous electrolyte into the electrode group in said sheathing material, a thin nonaqueous electrolyte rechargeable battery is assembled by closing opening of said sheathing material.
[0090] What was explained in the column of (4) nonaqueous electrolyte mentioned above as said nonaqueous electrolyte, and the same thing can be used.
[0091] In the manufacture approach mentioned above, although impregnation of the solution in which the macromolecule which has an adhesive property was dissolved was performed after containing the electrode group to the sheathing material, you may pour in, without containing to a sheathing material. In this case, first, a separator is made to intervene between a positive electrode and a negative electrode, and an electrode group is produced. After infiltrating said solution into said electrode group, the solvent of said solution is evaporated and the macromolecule which has an adhesive property in said positive electrode, a negative electrode, and the opening of a separator is made to exist by performing a vacuum drying to said electrode group. After containing such an electrode group to a sheathing material, nonaqueous electrolyte is poured in and a thin nonaqueous electrolyte rechargeable battery can be manufactured by performing obturation etc. Adhesives may be applied to an electrode group periphery before the receipt to a sheathing material. Thereby, an electrode group can be pasted up on a sheathing material. Moreover, a metal can can be used instead of a film as a sheathing material in this case.
[0092] (The 5th process) An initial charge is performed to the assembled rechargeable battery under 30 degrees C - 80 degrees C temperature conditions like the above at the charge rate of 0.05 or more C and 0.5 C or less. Charge on this condition is good only 1 cycle, and good in a line more than a two cycle. Moreover, you may keep it under a 30 degrees C - 80 degrees C temperature condition before an initial charge for 1 hour to about 20 hours.
[0093] Here, 1C charge rate is a current value required in order to charge nominal capacity (Ah) in 1 hour.
[0094] Specifying the temperature of said initial charge in said range is based on the following reasons. Since the viscosity of nonaqueous electrolyte is still high in initial charge temperature being less than 30 degrees C, it becomes difficult to infiltrate nonaqueous electrolyte into homogeneity to a positive electrode, a negative electrode, and a separator, internal impedance increases, and the utilization factor of an active material falls. On the other hand, if initial charge temperature exceeds 80 degrees C, the binder contained in a positive electrode and a negative electrode will deteriorate.
[0095] Since expansion of the positive electrode by charge and a negative electrode can be moderately made

late by making the charge rate of an initial charge into the range of 0.05-0.5C, nonaqueous electrolyte can be made to permeate a positive electrode and a negative electrode at homogeneity.
[0096] Since nonaqueous electrolyte can be infiltrated into the opening of an electrode or a separator by providing such a process at homogeneity, internal impedance which is 1kHz of a nonaqueous electrolyte rechargeable battery can be made small, and the product of 1kHz internal impedance can be carried out to cell capacity in the range below 110m ohm-Ah more than 10m ohm-Ah. Consequently, since the utilization factor of an active material can be increased, capacity of a substantial cell can be enlarged. Moreover, the charge-and-discharge cycle property and high current discharge property of a cell can be raised.
[0097] Subsequently, and a nonaqueous electrolyte rechargeable battery equipped with the nonaqueous electrolyte containing the non-aqueous solvent containing the gamma-butyrolactone below 95 volume % is explained than 50 volume % mentioned above with the electrode group which satisfies (b) mentioned above.
[0098] In this rechargeable battery, said positive electrode, said negative electrode, and said separator are unified by carrying out heat curing of the binder contained in said positive electrode and said negative electrode.

[0099] The column of (3) separators mentioned above having explained as said separator and the same thing are used. Moreover, the column of (6) sheathing materials mentioned above having explained as a sheathing material which contains said electrode group, and the same thing are used.
[0100] Said positive electrode has the structure where the positive-electrode layer containing an active material, a binder, and an electric conduction agent was supported by one side or both sides of a charge collector. The column of (1) positive electrode mentioned above having explained as said active material, a binder, an electric conduction agent, and a charge collector and the same thing are used.
[0101] Said negative electrode has the structure where the negative-electrode layer containing occlusion, the carbonaceous object to emit, and a binder was supported by one side or both sides of a charge collector in the lithium ion. The column of (2) negative electrodes mentioned above having explained as said carbonaceous object, a binder, and a charge collector and the same thing are used.
[0102] although said negative-electrode layer contains occlusion and the carbon matter to emit for the lithium ion mentioned above -- others -- metals, such as aluminum, magnesium, tin, and a silicon, a metallic oxide, and metallic sulfide -- or the metallic compounds chosen from a metal nitride and a lithium alloy may be included. The column of (2) negative electrodes mentioned above having explained as said metallic oxide, said metallic sulfide, said metal nitride, and said lithium alloy and the same thing are used.
[0103] This rechargeable battery is manufactured by the approach (II) explained below.
[0104] An electrode group is produced by the approach explained to (a) - (c) below <manufacture approach (II) > (the 1st process).
[0105] (a) Make a separator intervene between them and wind a positive electrode and a negative electrode around a curled form.
[0106] (b) Compress in the direction of a path after making a separator intervene between them and winding a positive electrode and a negative electrode around a curled form.
[0107] (c) Make a separator intervene between them and bend a positive electrode and a negative electrode twice or more.
[0108] (The 2nd process) Said electrode group is contained in the saccate sheathing material made from a film.
[0109] (The 3rd process) It fabricates, heating said electrode group at 40-120 degrees C.
[0110] When said electrode group is produced by the approach of the above (a) and said electrode group is produced by the approach of of the above (b) or (c) in the direction of a path, said shaping is performed so that it may be compressed in the direction of a laminating.
[0111] The insert lump by press forming or the die etc. can perform said shaping.
[0112] In case an electrode group is fabricated, the reason for heating said electrode group is explained. The macromolecule which has an adhesive property is not contained in said electrode group. For this reason, if it fabricates in ordinary temperature in this electrode group, springback will arise after shaping, that is, a clearance will be generated between a positive electrode, a separator, and a negative electrode and a separator. Consequently, since the touch area of a positive electrode and a separator and the touch area of a negative electrode and a separator fall, internal impedance becomes large. Since heat curing of the binder contained in a positive electrode and a negative electrode by fabricating above 40 degrees C in said electrode group can be

carried out, the degree of hardness of an electrode group can be raised. Consequently, since the springback after shaping can be controlled, the touch area is maintainable [the touch area of a positive electrode and a separator and the touch area of a negative electrode and a separator can be improved, and], even if it repeats a charge-and-discharge cycle. On the other hand, when the temperature of said electrode group exceeds 120 degrees C, there is a possibility that a separator may carry out a heat shrink sharply. More desirable temperature is 60-100 degrees C.
[0113] Shaping while heating to the specific temperature mentioned above can be performed for example, under ordinary pressure, reduced pressure, or a vacuum. If it carries out under reduced pressure or a vacuum, since the moisture removal effectiveness from an electrode group will improve, it is desirable.
[0114] When press forming performs said shaping, as for press **, it is desirable to make it the range of 0.01-20kg/cm2. This is based on the following reasons. When press ** is made lower than 0.01kg/cm2, there is a possibility that it may become difficult to control the springback after shaping. On the other hand, since there is a possibility that the voidage in an electrode group may fall when press ** is higher than 20kg/cm2, there is a possibility that the amounts of nonaqueous electrolyte maintenance of an electrode group may run short.
[0115] (The 4th process) After pouring nonaqueous electrolyte into the electrode group in said sheathing material, the nonaqueous electrolyte rechargeable battery mentioned above by closing opening of said sheathing material is assembled.
[0116] In the manufacture approach mentioned above, although fabricated heating an electrode group to specific temperature after containing the electrode group to the sheathing material, hot forming mentioned above before containing to a sheathing material may be performed. In this case, an electrode group is first produced according to the 1st process mentioned above. It fabricates heating said electrode group at 40-120 degrees C. Subsequently, after containing said electrode group to a sheathing material, nonaqueous electrolyte is poured in and the nonaqueous electrolyte rechargeable battery mentioned above by performing obturation etc. can be assembled. At this time, a metal can can be used instead of a film as a sheathing material.
[0117] (The 5th process) An initial charge is performed to the assembled rechargeable battery under 30 degrees C - 80 degrees C temperature conditions like the above at the charge rate of 0.05 or more C and 0.5 C or less. Charge on this condition is good only 1 cycle, and good in a line more than a two cycle. Moreover, you may keep it under a 30 degrees C - 80 degrees C temperature condition before an initial charge for 1 hour to about 20 hours.
[0118] Specifying the temperature of said initial charge and the charge rate of an initial charge in said range is based on the reason same with having mentioned above.
[0119] Since nonaqueous electrolyte can be infiltrated into the opening of an electrode or a separator by providing such a process at homogeneity, internal impedance which is 1kHz of a nonaqueous electrolyte rechargeable battery can be made small, and the product of 1kHz internal impedance can be carried out to cell capacity in the range below 110m ohm-Ah more than 10m ohm-Ah. Consequently, since the utilization factor of an active material can be increased, capacity of a substantial cell can be enlarged. Moreover, the charge-and-discharge cycle property and high current discharge property of a cell can be raised.
[0120] In addition, in the 1st nonaqueous electrolyte rechargeable battery concerning this invention, you may be the structure which wound the electrode group which consists of a positive electrode, a negative electrode, and a separator using the can which consists of aluminum etc. as a sheathing material, and was inserted in the can. In that case, the macromolecule which has jointing or an adhesive property is good for there to be nothing.
[0121] Subsequently, the 2nd nonaqueous electrolyte rechargeable battery concerning this invention is explained.
[0122] The positive electrode containing the positive-active-material layer with which this rechargeable battery is supported by one side or both sides of a positive-electrode charge collector and said positive-electrode charge collector, The negative electrode containing the negative-electrode active material layer which is supported by one side or both sides of a negative-electrode charge collector and said negative-electrode charge collector, and contains occlusion and the ingredient to emit for a lithium ion, Nonaqueous electrolyte which it sinks into the electrode group; aforementioned electrode group equipped with the separator arranged between said positive electrode and said negative electrode, and contains a non-aqueous solvent and the lithium salt dissolved in said non-aqueous solvent; sheathing-material; by which said electrode group is contained is provided.
[0123] The voidage of said positive-active-material layer is low compared with the voidage of said negative-

electrode active material layer. Moreover, the thickness of said positive-active-material layer is 10-100 micrometers. Furthermore, said non-aqueous solvent contains gamma-butyrolactone below 95 volume % more than 40 volume % of the whole non-aqueous solvent.
[0124] Although said positive electrode, said negative electrode, and said separator do not need to be unified, as for this rechargeable battery, it is desirable to be unified on conditions which are explained to the following (a) or (b).
[0125] (a) While said positive electrode and said separator are unified with the macromolecule which has the adhesive property which exists in a part of these boundaries [at least], said negative electrode and said separator are unified with the macromolecule which has the adhesive property which exists in a part of these boundaries [at least]. While being unified with the macromolecule which has the adhesive property with which these interior and boundaries are especially dotted with said positive electrode and said separator, it is desirable to be unified with the macromolecule which has the adhesive property with which these interior and boundaries are dotted with said negative electrode and said separator.
[0126] (b) Said positive electrode, said negative electrode, and said separator are unified by carrying out heat curing of the binder contained in said positive electrode and said negative electrode.
[0127] By making it this configuration of (a) or (b), bulging of a sheathing material can be reduced further.
[0128] Moreover, as for said rechargeable battery, it is desirable for the product of cell capacity (Ah) and 1kHz cell internal impedance (mohms) to be below 110m ohm-Ah more than 10mohm and Ah. By making the product of capacity and an impedance into said within the limits, a high current discharge property and a charge-and-discharge cycle property can be improved more. Here, cell capacity is the discharge capacity at the time of discharging by nominal capacity or 0.2C. More desirable range is below 60mohm and Ah more than 20mohm and Ah.
[0129] making the product of cell capacity and an impedance below into 110m ohm-Ah more than 10mohm and Ah -- for example, it is possible by the manufacture approach of of the manufacture approach of (I) mentioned above, or (II) mentioned above. However, in (I), more than 10m ohm-Ah, the product of cell capacity and an impedance sets up distribution of the addition of an adhesive macromolecule and an adhesive macromolecule, and initial charge conditions so that it may become below 110m ohm-Ah. Moreover, in (II), more than 10m ohm-Ah, the product of cell capacity and an impedance sets up the temperature, press **, and the initial charge conditions at the time of fabricating an electrode group so that it may become below 110m ohm-Ah.
[0130] A nonaqueous electrolyte rechargeable battery equipped with the electrode group which satisfies hereafter (a) mentioned above is explained.
[0131] 1) **** -- this positive electrode has the structure where the positive-active-material layer containing the macromolecule and binder which have an active material, an electric conduction agent, and an adhesive property was supported by one side or both sides of a charge collector.
[0132] The 1st nonaqueous electrolyte rechargeable battery mentioned above having explained as the macromolecule which has said active material, an electric conduction agent, and an adhesive property, and a binder, and the same thing can be mentioned.
[0133] Thickness of said positive-active-material layer is made into the range of 10-100 micrometers. Here, the thickness of a positive-active-material layer means the distance on the front face of positive active material which touches a separator, the positive-active-material front face which counters, and a charge collector. For example, as shown in drawing 4 , when the positive-active-material layer P is supported by both sides of a charge collector S, the distance on the front face P2 of positive active material which touches a separator, the positive-active-material front face P1 which counters, and a charge collector is thickness [of a positive-active-material layer] T. Therefore, when the positive-active-material layer is supported by both sides of a positive-electrode charge collector, the thickness of one side of a positive-active-material layer serves as range whose sum total thickness of a positive-active-material layer is 20-200 micrometers by 10-100 micrometers. If thickness of a positive-active-material layer is set to less than 10 micrometers, since the rate of a current collection weight quantitative ratio and the rate of a volume ratio will become high, energy density falls. The lower limit with desirable thickness is 30 micrometers, and a still more desirable lower limit is 50 micrometers. On the other hand, if the thickness of a positive-active-material layer exceeds 100 micrometers, since nonaqueous electrolyte will concentrate on a positive-electrode front face at the time of a rapid charge-and-discharge cycle and the electrode reaction in the interior of a positive electrode will hardly advance, a cycle life

falls. The upper limit with desirable thickness is 85 micrometers, and a still more desirable upper limit is 60 micrometers. As for especially the thickness of a positive-active-material layer, it is desirable to make it the range of 10-60 micrometers. A high current discharge property and a cycle life improve sharply that it is this within the limits. Furthermore, the desirable range is 30-50 micrometers.
[0134] The thickness of said positive-active-material layer is measured by the approach explained below. First, mutually, it separates 1cm or more, and ten existing points are chosen as arbitration, the thickness of each point is measured, and the thickness of a positive electrode is measured by computing the average. However, when the positive electrode which it is going to measure has the structure where the positive-active-material layer was supported by both sides of a charge collector, after removing positive-active-material layer of one of the two, the thickness of a positive electrode is measured. Subsequently, a positive-active-material layer is removed from a charge collector, and the thickness of a charge collector is measured. The thickness of a charge collector chooses as arbitration ten points which separate 1cm or more and exist mutually, measures the thickness of each point, and is called for by computing the average. Let the difference of the thickness of said positive electrode, and the thickness of said charge collector be the thickness of the positive-active-material layer for which it asks.

[0135] The voidage of said positive-active-material layer is low compared with the voidage of said negative-electrode active material layer. As for the voidage of said positive-active-material layer, it is desirable to make it 25 - 40% of range. This is based on the following reasons. When voidage is made less than 25%, even if it has regulated the thickness of a positive-active-material layer, there is a possibility that it may become difficult to make nonaqueous electrolyte permeate homogeneity. On the other hand, when voidage exceeds 40%, there is a possibility that it may become impossible to obtain high capacity, i.e., a high energy consistency. The more desirable range of voidage is 30 - 35%.
[0136] As said charge collector, the conductive substrate of a vesicular structure or a nonporous conductive substrate can be used. These conductivity substrate can be formed from aluminum, stainless steel, or nickel. As for the thickness of a charge collector, it is desirable to make it the range of 5-20 micrometers. It is because positive-electrode reinforcement and lightweight-izing can be balanced as it is this within the limits.
[0137] 2) **** -- this negative electrode has the structure where the negative-electrode active material layer containing the macromolecule and binder which have occlusion, the carbonaceous object to emit, and an adhesive property for a lithium ion was supported by one side or both sides of a charge collector.
[0138] The 1st nonaqueous electrolyte rechargeable battery mentioned above as occlusion, the carbonaceous object to emit, an electric conduction agent, the macromolecule which has an adhesive property, a binder, and a charge collector having explained said lithium ion, and the same thing can be mentioned.
[0139] As for the thickness of said negative-electrode active material layer, it is desirable to make it the range of 10-100 micrometers. Here, the thickness of a negative-electrode active material layer means distance with the negative-electrode active material front face which touches a separator, the negative-electrode active material front face which counters, and a charge collector. In addition, when the negative-electrode active material layer is supported by both sides of a negative-electrode charge collector, it is desirable to set thickness of one side of a negative-electrode active material layer to 10-100 micrometers, and to make sum total thickness of a negative-electrode active material layer into the range of 20-200 micrometers. If thickness of a negative-electrode active material layer is set to less than 10 micrometers, since the rate of a current collection weight quantitative ratio and the rate of a volume ratio will become high, there is a possibility that it may become difficult to fully raise energy density. The lower limit with desirable thickness is 30 micrometers, and a still more desirable lower limit is 50 micrometers. On the other hand, if the thickness of a negative-electrode active material layer exceeds 100 micrometers, since it will become easy to concentrate nonaqueous electrolyte on a negative-electrode front face, there is a possibility that it may become difficult to fully improve a cycle life. The upper limit with desirable thickness is 85 micrometers, and a still more desirable upper limit is 60 micrometers. As for especially the thickness of a negative-electrode active material layer, it is desirable to make it the range of 10-60 micrometers. A high current discharge property and a cycle life improve sharply that it is this within the limits. Furthermore, the desirable range is 30-50 micrometers.
[0140] The thickness of said negative-electrode active material layer is measured by the approach explained below. First, mutually, it separates 1cm or more, and ten existing points are chosen as arbitration, the thickness of each point is measured, and the thickness of a negative electrode is measured by computing the average.

However, when the negative electrode which it is going to measure has the structure where the negative-electrode active material layer was supported by both sides of a charge collector, after removing negative-electrode active material layer of one of the two, the thickness of a negative electrode is measured. Subsequently, a negative-electrode active material layer is removed from a charge collector, and the thickness of a charge collector is measured. The thickness of a charge collector chooses as arbitration ten points which separate 1cm or more and exist mutually, measures the thickness of each point, and is called for by computing the average. Let the difference of the thickness of said negative electrode, and the thickness of said charge collector be the thickness of the negative-electrode active material layer for which it asks.
[0141] As for the voidage of said negative-electrode active material layer, it is desirable to make it 35 - 50% of range. This is based on the following reasons. Since there is a possibility that distribution of nonaqueous electrolyte may become an ununiformity when voidage is made less than 35%, lithium DIN DORAIDO may deposit. On the other hand, when voidage exceeds 50%, there is a possibility that it may become impossible to obtain high capacity, i.e., a high energy consistency. The more desirable range of voidage is 35 - 45%.
[0142] As for the blending ratio of coal of said carbonaceous object and said binder, it is desirable that it is the range of 90 - 98 % of the weight of carbonaceous objects and 2 - 20 % of the weight of binders. Said especially carbonaceous object is 10 - 70 g/cm2 at one side, where a negative electrode is produced. It is desirable to make it the range.
[0143] The consistency of said negative-electrode active material layer is 1.20 - 1.50 g/cm3. It is desirable to make it the range.
[0144] As said charge collector, the conductive substrate of a vesicular structure or a nonporous conductive substrate can be used. These conductivity substrate can be formed from copper, stainless steel, or nickel. As for the thickness of a charge collector, it is desirable to make it the range of 5-20 micrometers. It is because negative-electrode reinforcement and lightweight-izing can be balanced as it is this within the limits.
[0145] although said negative-electrode active material layer contains occlusion and the carbon matter to emit for the lithium ion mentioned above -- instead of -- metals, such as aluminum, magnesium, tin, and a silicon, a metallic oxide, and metallic sulfide -- or the metallic compounds chosen from a metal nitride and a lithium alloy may be included.
[0146] The 1st nonaqueous electrolyte rechargeable battery mentioned above having explained as said metallic oxide, said metallic sulfide, said metal nitride, and said lithium alloy and the same thing can be mentioned.
[0147] 3) The separator of separator ** is formed from a porosity sheet.
[0148] The 1st nonaqueous electrolyte rechargeable battery mentioned above having explained as said porosity sheet and the same thing can be mentioned.
[0149] 4) The nonaqueous electrolyte aforementioned nonaqueous electrolyte is what dissolved lithium salt in the mixed non-aqueous solvent containing gamma-butyrolactone (BL), and the presentation ratio of BL is below 95 volume % more than 40 volume % of the mixed whole non-aqueous solvent. It is desirable to make [most] the presentation ratio of BL in said mixed non-aqueous solvent. Even if it has regulated the thickness of a positive-active-material layer as a ratio is under 40 volume %, it becomes easy to generate gas at the time of an elevated temperature. Moreover, since the ratio of annular carbonate becomes high relatively when a mixed non-aqueous solvent is a thing containing BL and annular carbonate, solvent viscosity becomes remarkably high. Consequently, since the conductivity and permeability of nonaqueous electrolyte fall sharply, even if it regulates the thickness of a positive-active-material layer, a charge-and-discharge cycle property, a high current discharge property, and the discharge property under the low-temperature environment near -20 degree C fall. On the other hand, if a ratio exceeds 95 volume %, since the reaction of a negative electrode and BL will arise, a charge-and-discharge cycle property falls. That is, if a negative electrode (for example, thing containing the carbonaceous object which carries out occlusion emission of the lithium ion), and BL react and reduction decomposition of nonaqueous electrolyte arises, the coat which checks a charge-and-discharge reaction on the surface of a negative electrode will be formed. Consequently, since it becomes easy to produce current concentration in a negative electrode, a lithium metal deposits, or the impedance of a negative-electrode interface becomes high, the charge-and-discharge effectiveness of a negative electrode falls to a negative-electrode front face, and the fall of a charge-and-discharge cycle property is caused. The more desirable range is below 90 volume % more than 60 volume %. While being able to make higher effectiveness which controls the generation of gas at the time of elevated-temperature storage by making it this range, the discharge capacity

under the low-temperature environment near -20 degree C can be improved more. Furthermore, the desirable range is below 90 volume % more than 75 volume %.
[0150] As a solvent mixed with BL, it is desirable at the point that annular carbonate raises the charge-and-discharge effectiveness of a negative electrode.
[0151] As said annular carbonate, (propylene carbonate PC) (ethylene carbonate EC) (vinylene carbonate VC) truffe ROROPURO pyrene carbonate (TFPC) etc. is desirable. If EC is used as a solvent especially mixed with BL, a charge-and-discharge cycle property and a high current discharge property can be improved sharply. Moreover, it is desirable at the point which raises a charge-and-discharge cycle property as it is the mixed solvent of the 3rd solvent and EC which are chosen from the group which consists of PC, VC, TFPC, diethyl carbonate (DEC), methylethyl carbonate (MEC), and an aromatic compound as other solvents mixed with BL, and which consist of a kind at least.
[0152] A hypoviscosity solvent may also be included below 20 volume % from a viewpoint in which solvent viscosity is furthermore reduced. As a hypoviscosity solvent, for example, chain-like carbonate, the chain-like ether, cyclic ether, etc. are mentioned.
[0153] The more desirable presentation of the non-aqueous solvent concerning this invention is BL, EC, and PC and VC. [BL, PC, BL and EC, DEC, BL and EC MEC, BL and EC, MEC, VC and BL, EC, VC and BL, PC and VC, or] [BL, EC,] As for the rate of a volume ratio of EC, at this time, it is desirable to consider as five to 40 volume %. This is based on the following reasons. Since there is a possibility that it may become difficult to cover a negative-electrode front face precisely by the protective coat when the ratio of EC is made under into 5 volume %, the reaction of a negative electrode and BL may arise and it may become difficult to fully improve a charge-and-discharge cycle property. On the other hand, since there is a possibility that the viscosity of nonaqueous electrolyte may become high and ionic conductivity may fall when the ratio of EC exceeds 40 volume %, it may become difficult to fully improve a charge-and-discharge cycle property, a high current discharge property, and a low-temperature discharge property. The still more desirable range of the ratio of EC is ten to 35 volume %. Moreover, the solvent which consists of at least one kind chosen from DEC, MEC, PC, and VC forms a precise protective coat on the surface of a negative electrode, and makes the operation which reduces the interface impedance of a negative electrode. Especially the addition of this solvent is not limited and is set as an amount which this operation produces. However, when the ratio of at least one kind of solvent chosen from DEC, MEC, PC, and VC in a non-aqueous solvent exceeds 10 volume %, there is a possibility that fully controlling may become difficult about nonaqueous electrolyte carrying out oxidative degradation under hot environments, or the viscosity of nonaqueous electrolyte may become high, and ion conductivity may fall. For this reason, as for the rate of a volume ratio of at least one kind of solvent chosen from DEC, MEC, PC, and VC in a non-aqueous solvent, it is desirable to carry out to below 10 volume %. Furthermore, the desirable rate of a volume ratio is below 2 volume %. Moreover, the lower limit with desirable still more desirable making the lower limit of the rate of a volume ratio into 0.001 volume % is 0.05 volume %.
[0154] The non-aqueous solvent which contains BL, EC, and VC of 40 - 95 volume % especially is desirable. Since the nonaqueous electrolyte rechargeable battery equipped with the nonaqueous electrolyte containing this non-aqueous solvent and the negative electrode containing the carbonaceous object which carries out occlusion emission of the lithium ion can control that a metal lithium deposits in a negative electrode while being able to reduce the impedance of the interface of a negative electrode sharply, it can improve the charge-and-discharge effectiveness of a negative electrode. Consequently, realizing the outstanding high current discharge property and a longevity life, the generation of gas at the time of elevated-temperature storage can be controlled, and deformation of a sheathing material can be suppressed. Thus, it is guessed that it is what is depended on an operation which is explained below that a negative-electrode property is improved. In said rechargeable battery, the protective film by EC is formed in the front face of said negative electrode, and it is alike, in addition the thin and precise coat by VC is formed. Consequently, since the reaction of BL and a negative electrode is suppressed further, it is thought that the fall of an impedance and deposit prevention of a metal lithium are attained.
[0155] Moreover, although it has the presentation mentioned above as a non-aqueous solvent, the thing containing BL, EC, and the aromatic compound of 40 - 95 volume % may be used instead. As said aromatic compound, at least one kind chosen from benzene, toluene, a xylene, a biphenyl, and a terphenyl can be mentioned, for example. EC can adhere on the surface of a negative electrode (for example, thing containing the

carbonaceous object which carries out occlusion emission of the lithium ion), can form a protective coat, and can control the reaction of a negative electrode and BL. As for the rate of a volume ratio of EC, at this time, it is desirable to consider as five to 40 volume % for the reason same with having mentioned above. Moreover, the still more desirable range of the ratio of EC is ten to 35 volume %. On the other hand, since it is easy to stick on the surface of a negative electrode (for example, thing containing the carbonaceous object which carries out occlusion emission of the lithium ion) to the benzene ring of said aromatic compound, it can control the reaction of a negative electrode and BL. Therefore, since the nonaqueous electrolyte containing the non-aqueous solvent containing BL, EC, and the aromatic compound of 40 - 95 volume % can fully suppress the reaction of a negative electrode and BL, it can improve the charge-and-discharge cycle property of a rechargeable battery. As for such a non-aqueous solvent, it is desirable that the solvent which consists of at least one kind chosen from DEC, MEC, PC, TFPC, and VC further is included. Since the reaction of a negative electrode and BL can be further controlled by adding the solvent which consists of at least one kind chosen from DEC, MEC, PC, TFPC, and VC, a charge-and-discharge cycle property can be improved further. Especially, VC is desirable. Especially the addition of the 3rd solvent which consists of at least one kind chosen from an aromatic compound, DEC, MEC and PC, TFPC, and VC is not limited, and is set as an amount which this operation produces. However, when the ratio of said 3rd solvent in a non-aqueous solvent exceeds 10 volume %, there is a possibility that fully controlling may become difficult about nonaqueous electrolyte carrying out oxidative degradation under hot environments, or the viscosity of nonaqueous electrolyte may become high, and ion conductivity may fall. For this reason, as for the rate of a volume ratio of said 3rd solvent in a non-aqueous solvent, it is desirable to carry out to below 10 volume %. Furthermore, the desirable rate of a volume ratio is below 2 volume %. Moreover, the lower limit with desirable still more desirable making the lower limit of the rate of a volume ratio into 0.001 volume % is 0.05 volume %.

[0156] The 1st nonaqueous electrolyte rechargeable battery mentioned above having explained as an electrolyte contained in said nonaqueous electrolyte and the same thing can be mentioned. Especially, it is LiPF6. Or LiBF4 Using is desirable.

[0157] As for the amount of dissolutions to said non-aqueous solvent of said electrolyte, it is desirable to carry out in 0.5-2.0 mols/l.

[0158] In said nonaqueous electrolyte, in order [with a separator] to be smeared and to improve a sex, surfactants, such as trioctylphosphate, may be added in 0.1 - 1% of range.

[0159] As for the amount of said nonaqueous electrolyte, it is desirable to make it per [0.2-0.6g] cell unit capacity 100mAh for the same reason as for the 1st nonaqueous electrolyte rechargeable battery mentioned above to have explained. The more desirable range of the amount of nonaqueous electrolyte is 0.4-0.55g/100mAh.

[0160] 5) As for the macromolecule which has the macromolecule aforementioned adhesive property which has an adhesive property, it is desirable that it is what can maintain a high adhesive property where nonaqueous electrolyte is held. Furthermore, when this giant molecule has high lithium ion conductivity, in addition, it is desirable. The 1st nonaqueous electrolyte rechargeable battery mentioned above having specifically explained and the same thing can be mentioned. Especially, polyvinylidene fluoride is desirable.

[0161] As for the macromolecule which has said adhesive property, it is desirable to take the vesicular structure which has a detailed hole in a positive electrode, a negative electrode, and the opening of a separator. The macromolecule which has the adhesive property which has a vesicular structure can hold nonaqueous electrolyte.

[0162] As for the total amount of the macromolecule which has the adhesive property included in said cell, it is desirable to make it 0.1-6mg per cell capacity 100mAh for the same reason as for the 1st nonaqueous electrolyte rechargeable battery mentioned above to have explained. The more desirable range of the total amount of the macromolecule which has an adhesive property is 0.2-1mg per cell capacity 100mAh.

[0163] 6) The 2nd sheathing material 0.3mm or less is used for the sheathing material of ******** for the 1st sheathing material which the thickness containing a resin layer becomes from a sheet 0.5mm or less, and thickness. Said the 1st sheathing material and said 2nd sheathing material are as the 1st nonaqueous electrolyte rechargeable battery mentioned above having explained.

[0164] When using said sheathing material made from a film, it is desirable for said electrode group to have pasted the inside of said sheathing material by the glue line formed in a part of the front face [at least]. If it is

made such a configuration, since said sheathing material is fixable to the front face of said electrode group, it can suppress that the electrolytic solution permeates between an electrode group and a sheathing material.
[0165] The thin rechargeable lithium-ion battery which is an example of this nonaqueous electrolyte rechargeable battery is explained to a detail with reference to drawing 5 - drawing 7 .
[0166] The sectional view showing the thin rechargeable lithium-ion battery whose drawing 5 is an example of the 2nd [concerning this invention] nonaqueous electrolyte rechargeable battery, the expanded sectional view in which drawing 6 shows the B section of drawing 5 , and drawing 7 are the mimetic diagrams showing near the boundary of the positive-electrode layer in the rechargeable battery of drawing 5 , a separator, and a negative-electrode layer.
[0167] As shown in drawing 5 , the sheathing material 21 which consists of a film is surrounding the electrode group 22. Said electrode group 22 has the structure where the laminated material which consists of a positive electrode, a separator, and a negative electrode was wound around the flat configuration. As said laminated material is shown in drawing 6 (from the drawing bottom) A separator 23, the positive-electrode layer 24 and the positive-electrode charge collector 25, the positive electrode 32 equipped with the positive-electrode layer 24, a separator 23 and the negative-electrode layer 26, the negative-electrode charge collector 27, the negative electrode 33 equipped with the negative-electrode layer 26, a separator 23 and the positive-electrode layer 24, the positive-electrode charge collector 25, and the positive-electrode layer 24 The negative electrode 33 equipped with the positive electrode 32 which it had, the separator 23, and the negative-electrode layer 26 and the negative-electrode charge collector 27 carried out the laminating to this sequence. As for said electrode group 22, said negative-electrode charge collector 27 is located in the outermost layer. As for the front face of said electrode group 22, jointing 28 exists. The inside of said sheathing material 21 is pasted up on said jointing 28. As shown in drawing 7 , the macromolecule 29 which has an adhesive property is held in the opening of the positive-electrode layer 24, a separator 23, and the negative-electrode layer 26, respectively. The positive electrode 32 and the separator 23 are pasted up with the macromolecule 29 which has the adhesive property with which the interior and these boundaries of the positive-electrode layer 24 and a separator 23 are dotted. On the other hand, the negative electrode 33 and the separator 23 are pasted up with the macromolecule 29 which has the adhesive property with which the interior and these boundaries of the negative-electrode layer 26 and a separator 23 are dotted. Nonaqueous electrolyte sinks into said electrode group 22 in said sheathing material 21. The end was connected to said positive-electrode charge collector 25 of said electrode group 22, and, as for the band-like positive-electrode lead 30, the other end has extended from said sheathing material 21. On the other hand, the end was connected to said negative-electrode charge collector 27 of said electrode group 22, and, as for the band-like negative-electrode lead 31, the other end has extended from said sheathing material 21.
[0168] In addition, in drawing 5 mentioned above, although jointing 28 was formed in the whole front face of the electrode group 22, jointing 28 may be formed in a part of electrode group 2. When forming jointing 28 in a part of electrode group 22, it is desirable to form in the field which is equivalent to the outermost periphery of an electrode group at least. Moreover, there may not be jointing 28.
[0169] A nonaqueous electrolyte rechargeable battery equipped with the electrode group which satisfies this condition of (a) mentioned above For example, the process which a porosity sheet is made to intervene as a separator between the manufacture approach explained in the 1st nonaqueous electrolyte rechargeable battery mentioned above (I), i.e., a positive electrode, and a negative electrode, and produces an electrode group, The process which infiltrates into said electrode group the solution obtained by dissolving the macromolecule which has an adhesive property in a solvent, To the process which performs a vacuum drying to said electrode group, the process which assembles a thin nonaqueous electrolyte rechargeable battery by sealing said electrode group in said sheathing material after infiltrating nonaqueous electrolyte into said electrode group, and said rechargeable battery, under 30 degrees C - 80 degrees C temperature conditions It is manufactured by the approach of providing the process which performs an initial charge at the charge rate of 0.05 or more C and 0.5 C or less. However, if the manufacture approach of the nonaqueous electrolyte rechargeable battery concerning this invention is in the range of this invention, it will not be limited to the above-mentioned gestalt.
[0170] Subsequently, a nonaqueous electrolyte rechargeable battery equipped with the nonaqueous electrolyte containing the non-aqueous solvent containing the electrode group which satisfies (b) mentioned above, and the gamma-butyrolactone of 40 - 95 volume % mentioned above is explained.
[0171] In this rechargeable battery, said positive electrode, said negative electrode, and said separator are

unified by carrying out heat curing of the binder contained in said positive electrode and said negative electrode.

[0172] The column of (3) separators in the 2nd nonaqueous electrolyte rechargeable battery mentioned above having explained as said separator and the same thing are used. Moreover, the column of (6) sheathing materials in the 2nd nonaqueous electrolyte rechargeable battery which was mentioned above and which was mentioned above having explained as a sheathing material which contains said electrode group, and the same thing are used.
[0173] Said positive electrode has the structure where the positive-active-material layer containing an active material, a binder, and an electric conduction agent was supported by one side or both sides of a charge collector. The column of (1) positive electrode in the 2nd nonaqueous electrolyte rechargeable battery which was mentioned above and which was mentioned above having explained as said active material, a binder, an electric conduction agent, and a charge collector and the same thing are used.
[0174] Thickness of said positive-active-material layer is made into the range of 10-100 micrometers for the reason same with having mentioned above. In addition, when the positive-active-material layer is supported by both sides of a positive-electrode charge collector, the sum total thickness of a positive-active-material layer serves as the range of 20-200 micrometers. The range where it is desirable still more desirable setting the lower limit of a positive-active-material layer to 30 micrometers is 50 micrometers. On the other hand, the range where it is desirable still more desirable setting the upper limit of a positive-active-material layer to 85 micrometers is 60 micrometers. As for the thickness of a positive-active-material layer, it is desirable to make it the range of 10-60 micrometers for the reason same with having explained in the 2nd nonaqueous electrolyte rechargeable battery mentioned above. Furthermore, the desirable range is 30-50 micrometers.
[0175] The voidage of said positive-active-material layer is low compared with the voidage of said negative-electrode active material layer. As for the voidage of said positive-active-material layer, it is desirable to make it 25 - 40% of range for the reason same with having mentioned above. The more desirable range of voidage is 30 - 35%.
[0176] Said negative electrode has the structure where the negative-electrode active material layer containing occlusion, the carbonaceous object to emit, and a binder was supported by one side or both sides of a charge collector in the lithium ion. The column of (2) negative electrodes in the 2nd nonaqueous electrolyte rechargeable battery mentioned above having explained as said carbonaceous object, a binder, and a charge collector and the same thing are used.
[0177] As for the thickness of said negative-electrode active material layer, it is desirable to make it the range of 10-100 micrometers for the reason same with having mentioned above. In addition, when the negative-electrode active material layer is supported by both sides of a negative-electrode charge collector, it is desirable to make sum total thickness of a negative-electrode active material layer into the range of 20-200 micrometers. The range where it is desirable still more desirable setting the lower limit of a negative-electrode active material layer to 30 micrometers is 50 micrometers. On the other hand, the range where it is desirable still more desirable setting the upper limit of a negative-electrode active material layer to 85 micrometers is 60 micrometers. As for the thickness of a negative-electrode active material layer, it is desirable to make it the range of 10-60 micrometers for the reason same with having explained in the 2nd nonaqueous electrolyte rechargeable battery mentioned above. Furthermore, the desirable range is 30-50 micrometers.
[0178] As for the voidage of said negative-electrode active material layer, it is desirable to make it 35 - 50% of range for the reason same with having mentioned above. The more desirable range of voidage is 35 - 45%.
[0179] As for the blending ratio of coal of said carbonaceous object and said binder, it is desirable that it is the range of 90 - 98 % of the weight of carbonaceous objects and 2 - 20 % of the weight of binders. Said especially carbonaceous object is 10 - 70 g/cm2 at one side, where a negative electrode is produced. It is desirable to make it the range.
[0180] The consistency of said negative-electrode active material layer is 1.20 - 1.50 g/cm3. It is desirable to make it the range.
[0181] This rechargeable battery For example, the manufacture approach explained in the 1st nonaqueous electrolyte rechargeable battery mentioned above (II), i.e., the process which intervenes a separator between a positive electrode and a negative electrode, and creates an electrode group, The process fabricated while heating said electrode group at 40-120 degrees C, and the process which assembles a nonaqueous electrolyte

rechargeable battery by sealing said electrode group to a sheathing material after infiltrating nonaqueous electrolyte into said electrode group, It is manufactured by the approach of providing the process which performs an initial charge under 30 degrees C - 80 degrees C temperature conditions at the charge rate of 0.05 or more C and 0.5 C or less in said rechargeable battery.
[0182] In addition, in the 2nd nonaqueous electrolyte rechargeable battery concerning this invention, you may be the structure which wound the electrode group which consists of a positive electrode, a negative electrode, and a separator using the can which consists of aluminum etc. as a sheathing material, and was inserted in the can. In that case, the macromolecule which has jointing or an adhesive property is good for there to be nothing.
[0183] Nonaqueous electrolyte which it sinks into the electrode group; aforementioned electrode group equipped with the separator with which the nonaqueous electrolyte rechargeable battery concerning this invention is arranged in a positive electrode and a lithium ion between the negative electrode containing occlusion and the ingredient to emit, and said positive electrode and said negative electrode as explained in full detail above, and contains a non-aqueous solvent and the lithium salt dissolved in said non-aqueous solvent; the thickness by which said electrode group is contained possesses 0.3mm or less sheathing-material;. Moreover, from 50 volume % of the whole non-aqueous solvent, there are many said non-aqueous solvents and they contain gamma-butyrolactone below 95 volume %.
[0184] In the nonaqueous electrolyte rechargeable battery, it is requested that thickness is made thin with about 3-4mm. Since cell capacity falls, it is not desirable to make thickness of an electrode group thin for thin-shape-izing. In order to make thickness thin, without sacrificing cell capacity, it is necessary to make thickness of a sheathing material thin. However, if thickness of a sheathing material is set to 0.3mm or less, a sheathing material will deform by the gas which occurs in elevated-temperature ******. For this reason, it was difficult for thickness to use a sheathing material 0.3mm or less, and the sacrifice of cell capacity had followed on thin shape-ization of a cell.
[0185] Since gamma-butyrolactone is excellent in chemical stability, positive active material and nonaqueous electrolyte can control that nonaqueous electrolyte carries out oxidative degradation in response to the time of storing under a high temperature service by carrying out the amount content of specification of the gamma-butyrolactone into a non-aqueous solvent. Consequently, since the amount of generation of gas can be lessened, it can stop that a sheathing material with as thin thickness as 0.3mm or less blisters. Therefore, since thin shape-ization can be attained without maintaining a practical high current discharge property and a charge-and-discharge cycle property, and making most cell capacity into a sacrifice, it excels in a high current discharge property, and weight energy density and volume energy density can realize a thin high nonaqueous electrolyte rechargeable battery long lasting.
[0186] Since it can control that a negative electrode and gamma-butyrolactone react and nonaqueous electrolyte understands a returned part by making charge temperature into 30-80 degrees C, and setting a charge rate to 0.05-0.5C in case an initial charge is performed to said rechargeable battery, the interface impedance of a negative electrode can be made low, and a deposit of a metal lithium can be suppressed. Therefore, the high current discharge property and charge-and-discharge cycle property of said rechargeable battery can be improved.
[0187] In the rechargeable battery concerning this invention, since the ionic conductivity of nonaqueous electrolyte can be improved by making concentration of the lithium salt of nonaqueous electrolyte into 0.5 or more mol/l, a high current discharge property and a cycle life can be improved more.
[0188] In the rechargeable battery concerning this invention, since a protective coat can be formed on the surface of a negative electrode when said non-aqueous solvent contains ethylene carbonate further in case the thing containing the carbonaceous object which carries out occlusion emission of the lithium ion as a negative electrode is used, the reaction of a negative electrode and gamma-butyrolactone can be controlled further, and a high current discharge property and a cycle life can be improved more. Since a negative-electrode front face can be precisely covered by the protective coat by making the 3rd solvent which turns into this non-aqueous solvent from at least one kind chosen from vinylene carbonate, propylene carbonate, diethyl carbonate, methylethyl carbonate, a truffe ROROPURO pyrene, and an aromatic compound contain further, the reaction of a negative electrode and gamma-butyrolactone can be reduced sharply, and a high current discharge property and a cycle life can be improved further.
[0189] In the rechargeable battery concerning this invention, a high current discharge property and a cycle life

can be raised more by making the product of cell capacity (Ah) and 1kHz cell internal impedance (mohms) below into 110m ohm-Ah more than 10m ohm-Ah.

[0190] It sets to the rechargeable battery concerning this invention, and, for said separator, air permeability is 600 second / 100cm3. By including the porosity sheet which is the following, the nonaqueous electrolyte which carried out the amount content of specification of the gamma-butyrolactone mentioned above can be infiltrated into homogeneity to a separator. Consequently, since the ionic conductivity of a separator can be improved, a high current discharge property and a cycle life can be raised more.

[0191] By the way, the force which follows at expansion and contraction of the electrode group accompanying [thickness / which is contained in the rechargeable battery concerning this invention] a charge-and-discharge reaction in a sheathing material 0.3mm or less, is easy to transform, and pinches an electrode group is weak. For this reason, when a charge-and-discharge cycle advances, there is a possibility that the touch area of a positive electrode and a separator and the touch area of a negative electrode and a separator may decrease. While unifying with the macromolecule which has the adhesive property which exists said positive electrode and said separator in a part of these boundaries [at least], even if a charge-and-discharge cycle advances, a negative electrode and a separator can be pasted up on a positive electrode and a separator list by unifying with the macromolecule which has the adhesive property which exists said negative electrode and said separator in a part of these boundaries [at least]. Consequently, since the rise of internal impedance can be suppressed, a cycle life can be improved more. To coincidence, the generation of gas at the time of an elevated temperature can be reduced further.

[0192] In the rechargeable battery concerning this invention, while making it unify with the macromolecule which has the adhesive property with which these interior and boundaries are dotted in said positive electrode and said separator, the bond strength of a negative electrode and a separator can be improved in the bond strength list of a positive electrode and a separator, keeping internal resistance low by making it unify with the macromolecule which has the adhesive property with which these interior and boundaries are dotted in said negative electrode and said separator. Consequently, since the rise of internal impedance can be suppressed, a cycle life can be improved more. To coincidence, the generation of gas at the time of an elevated temperature can be reduced further.

[0193] In the rechargeable battery concerning this invention, keeping internal resistance low by making it unify by carrying out heat curing of the binder contained in said positive electrode and said negative electrode in said positive electrode, said negative electrode, and said separator, the touch area of a negative electrode and a separator can be improved in the touch-area list of a positive electrode and a separator, and the touch area can be maintained, even if it repeats a charge-and-discharge cycle. Consequently, since the rise of internal impedance can be suppressed, a cycle life can be improved more. To coincidence, the generation of gas at the time of an elevated temperature can be reduced further.

[0194] Moreover, the manufacture approach of the nonaqueous electrolyte rechargeable battery concerning this invention It sinks into said electrode group. An electrode group equipped with the separator arranged in a positive electrode and a lithium ion between the negative electrode containing occlusion and the ingredient to emit, and a positive electrode and a negative electrode; A non-aqueous solvent, It is the manufacture approach of a nonaqueous electrolyte rechargeable battery of providing nonaqueous electrolyte; containing the lithium salt dissolved in said non-aqueous solvent. Said non-aqueous solvent The process which contains gamma-butyrolactone below 95 volume % more than 55 volume % of the whole non-aqueous solvent, and performs an initial charge at 0.05 or more C charge rate of 0.5 or less C with 30-degree-C or more temperature of 80 degrees C or less is provided.

[0195] According to the manufacture approach of the nonaqueous electrolyte rechargeable battery of this invention, since said nonaqueous electrolyte can be made to permeate in the inside of an electrode, or a separator well, the impedance of a rechargeable battery can be made small, the utilization factor of an active material can be made high, and a substantial cell capacity can be improved.

[0196] Moreover, nonaqueous electrolyte which it sinks into the electrode group; aforementioned electrode group equipped with the separator with which the nonaqueous electrolyte rechargeable battery concerning this invention is arranged in a positive electrode and a lithium ion between the negative electrode containing occlusion and the ingredient to emit, and said positive electrode and said negative electrode, and contains a non-aqueous solvent and the lithium salt dissolved in said non-aqueous solvent; said electrode group is contained

and sheathing-material; which the thickness containing a resin layer becomes from a sheet 0.5mm or less is provided. Moreover, from 50 volume % of the whole non-aqueous solvent, there are many said non-aqueous solvents and they contain gamma-butyrolactone below 95 volume %.
[0197] According to such a rechargeable battery, since the amount of generation of gas can be lessened, it can stop that the sheathing material which the thickness containing a resin layer becomes from a sheet 0.5mm or less blisters. Consequently, since use of a lightweight sheathing material is attained and a high current discharge property practical moreover and a charge-and-discharge cycle property can be maintained, it excels in a high current discharge property, and a nonaqueous electrolyte rechargeable battery with high weight energy density can be realized long lasting.
[0198] The positive electrode containing the positive-active-material layer with which the nonaqueous electrolyte rechargeable battery concerning this invention is supported by one side or both sides of a positive-electrode charge collector and said positive-electrode charge collector, The negative electrode containing the negative-electrode active material layer which is supported by one side or both sides of a negative-electrode charge collector and said negative-electrode charge collector, and contains occlusion and the ingredient to emit for a lithium ion, Nonaqueous electrolyte which it sinks into the electrode group; aforementioned electrode group equipped with the separator arranged between said positive electrode and said negative electrode, and contains a non-aqueous solvent and the lithium salt dissolved in said non-aqueous solvent; the thickness by which said electrode group is contained possesses 0.3mm or less sheathing-material;. The voidage of said positive-active-material layer is low compared with the voidage of said negative-electrode active material layer. Moreover, the thickness of said positive-active-material layer is 10-100 micrometers. Furthermore, said non-aqueous solvent contains gamma-butyrolactone below 95 volume % more than 40 volume % of the whole non-aqueous solvent.
[0199] In a nonaqueous electrolyte rechargeable battery, when a bias is in distribution of the nonaqueous electrolyte of a negative electrode, current concentration arises in a negative electrode and lithium DIN DORAIDO becomes easy to deposit. In order to avoid this, in the negative electrode, voidage is made high and the permeability of nonaqueous electrolyte is raised. On the other hand, if about [that such a problem does not arise] and voidage is made to be the same as that of a negative electrode in a positive electrode, positive-active-material bed density will fall and a high capacity will no longer be obtained. Since it is such, making voidage of positive active material low compared with a negative-electrode active material layer is performed.
[0200] By the way, the nonaqueous electrolyte containing gamma-butyrolactone cannot tend to permeate homogeneity in an electrode like a positive electrode or a negative electrode easily. If it is going to infiltrate a positive electrode with the low voidage which mentioned this nonaqueous electrolyte above, since only a front face cannot be made to permeate, a cycle life falls remarkably.
[0201] Like the invention in this application, the electrolytic-solution permeability of a positive-active-material layer is improvable by setting thickness of a positive-active-material layer with low voidage to 10-100 micrometers. Consequently, since the nonaqueous electrolyte containing gamma-butyrolactone can be made to permeate homogeneity to the both sides of a positive-active-material layer and a negative-electrode active material layer, the outstanding oxidation resistance which is the features of gamma-butyrolactone can be employed efficiently fully, the generation of gas at the time of storing under a high temperature service can be controlled by the nonaqueous electrolyte which contains the non-aqueous solvent containing the gamma-butyrolactone below 95 volume % more than 40 volume %, and it can stop that a sheathing material with as thin thickness as 0.3mm or less blisters. Therefore, since thin shape-ization can be attained without maintaining a practical high current discharge property and a charge-and-discharge cycle property, and making most cell capacity into a sacrifice, it excels in a high current discharge property, and weight energy density and volume energy density can realize a thin high nonaqueous electrolyte rechargeable battery long lasting.
[0202] Since it can control that a negative electrode and gamma-butyrolactone react and nonaqueous electrolyte understands a returned part by making charge temperature into 30-80 degrees C, and setting a charge rate to 0.05-0.5C in case an initial charge is performed to said rechargeable battery, the interface impedance of a negative electrode can be made low, and a deposit of a metal lithium can be suppressed. Therefore, the high current discharge property and charge-and-discharge cycle property of said rechargeable battery can be improved.
[0203] In the rechargeable battery concerning this invention, since the electrolytic-solution permeability of a

negative-electrode active material layer can be improved by setting thickness of a negative-electrode active material layer to 10-100 micrometers, the amount of generation of gas of elevated-temperature ****** can be lessened further, and a high current discharge property and a charge-and-discharge cycle property can be improved more.
[0204] In the rechargeable battery concerning this invention, since the ionic conductivity of nonaqueous electrolyte can be improved by making concentration of the lithium salt of nonaqueous electrolyte into 0.5 or more mol/l, a high current discharge property and a cycle life can be improved more.
[0205] In the rechargeable battery concerning this invention, since a protective coat can be formed on the surface of a negative electrode when said non-aqueous solvent contains ethylene carbonate further in case the thing containing the carbonaceous object which carries out occlusion emission of the lithium ion as a negative electrode is used, the reaction of a negative electrode and gamma-butyrolactone can be controlled further, and a high current discharge property and a cycle life can be improved more. Since a negative-electrode front face can be precisely covered by the protective coat by making the 3rd solvent which turns into this non-aqueous solvent from at least one kind chosen from vinylene carbonate, propylene carbonate, diethyl carbonate, methylethyl carbonate, a truffe ROROPURO pyrene, and an aromatic compound contain further, the reaction of a negative electrode and gamma-butyrolactone can be reduced sharply, and a high current discharge property and a cycle life can be improved further.
[0206] It sets to the rechargeable battery concerning this invention, and, for said separator, air permeability is 600 second / 100cm3. By including the porosity sheet which is the following, the nonaqueous electrolyte which carried out the amount content of specification of the gamma-butyrolactone mentioned above can be infiltrated into homogeneity to a separator. Consequently, since the ionic conductivity of a separator can be improved, a high current discharge property and a cycle life can be raised more.
[0207] In the rechargeable battery concerning this invention, since the rise of the internal impedance accompanying advance of a charge-and-discharge cycle can be suppressed by unifying with the macromolecule which has the adhesive property which exists said negative electrode and said separator in a part of these boundaries [at least] while unifying with the macromolecule which has the adhesive property which exists said positive electrode and said separator in a part of these boundaries [at least], a cycle life can be improved more. To coincidence, the generation of gas at the time of an elevated temperature can be reduced further.
[0208] While making it unify with the macromolecule which has the adhesive property with which these interior and boundaries are dotted in said positive electrode and said separator in the rechargeable battery concerning this invention By making it unify with the macromolecule which has the adhesive property with which these interior and boundaries are dotted in said negative electrode and said separator Internal impedance in early stages of a charge-and-discharge cycle can be made low, and since the value is maintainable even if a charge-and-discharge cycle advances, a cycle life can be improved more. To coincidence, the generation of gas at the time of an elevated temperature can be reduced further.
[0209] In the rechargeable battery concerning this invention, since it is maintainable by making it unify by carrying out heat curing of the binder contained in said positive electrode and said negative electrode in said positive electrode, said negative electrode, and said separator even if it can make low internal impedance in early stages of a charge-and-discharge cycle and a charge-and-discharge cycle advances the value, a cycle life can be improved more. To coincidence, the generation of gas at the time of an elevated temperature can be reduced further.
[0210] Moreover, the positive electrode containing the positive-active-material layer with which the nonaqueous electrolyte rechargeable battery concerning this invention is supported by one side or both sides of a positive-electrode charge collector and said positive-electrode charge collector, The negative electrode containing the negative-electrode active material layer which is supported by one side or both sides of a negative-electrode charge collector and said negative-electrode charge collector, and contains occlusion and the ingredient to emit for a lithium ion, It sinks into said electrode group. An electrode group equipped with the separator arranged between said positive electrode and said negative electrode; A non-aqueous solvent, Nonaqueous electrolyte containing the lithium salt dissolved in said non-aqueous solvent; said electrode group is contained and sheathing-material; which the thickness containing a resin layer becomes from a sheet 0.5mm or less is provided. The voidage of said positive-active-material layer is low compared with the voidage of said negative-electrode active material layer. The thickness of said positive-active-material layer is 10-100

micrometers. Furthermore, said non-aqueous solvent contains gamma-butyrolactone below 95 volume % more than 40 volume % of the whole non-aqueous solvent.
[0211] According to such a rechargeable battery, since the amount of generation of gas can be lessened, it can stop that the sheathing material which the thickness containing a resin layer becomes from a sheet 0.5mm or less blisters. Consequently, since use of a lightweight sheathing material is attained and a high current discharge property practical moreover and a charge-and-discharge cycle property can be maintained, it excels in a high current discharge property, and a nonaqueous electrolyte rechargeable battery with high weight energy density can be realized long lasting.
[0212]
[Example] Hereafter, the desirable example of this invention is explained to a detail.
[0213] (Example 1)
<production of a positive electrode> -- first -- a lithium cobalt oxide (Lix CoO2; however) X 91 % of the weight of powder which is 0<=X<=1 3.5 % of the weight of acetylene black, Add [both] 3.5 % of the weight of graphite, 2 % of the weight of ethylene propylen dien monomer powder, and toluene, and it mixes. 10cm2 Electrode consistencies are 3 g/cm3 by pressing, after applying to both sides of the charge collector which consists of porosity aluminium foil (thickness is 15 micrometers) with which a hole with a diameter of 0.5mm exists at a rate of ten hits. The positive electrode of the structure where the positive-electrode layer was supported by both sides of a charge collector was produced.
[0214] The powder of a mesophase pitch based carbon fiber (for 8 micrometers and mean fiber length, 20 micrometers and an average spacing (d002) are [the diameter of fiber] 0.3360nm) heat-treated at 3000 degrees C as a <production of negative electrode> carbonaceous ingredient 93 % of the weight, 7 % of the weight (PVdF) of polyvinylidene fluorides is mixed as a binder. this -- 10cm2 per -- applying to the charge collector which consists of ten porosity copper foil (thickness is 15 micrometers) in which it appears comparatively and a hole with a diameter of 0.5mm exists, and drying and pressing in it -- an electrode consistency -- 1.3 g/cm3 The negative electrode of the structure where the negative-electrode layer was supported by the charge collector was produced.
[0215] 25 micrometers, 120 degrees C, and a heat shrink in 1 hour prepared [<separator> thickness] the separator which consists of a porosity film made from polyethylene whose porosity is 50% at 20%.
[0216] <Preparation of nonaqueous electrolyte> 4 lithium borate fluoride (LiBF4) was dissolved in the mixed solvent (rate 25:75 of a mixed volume ratio) of ethylene carbonate (EC) and gamma-butyrolactone (BL) 1.5 mols / 1, and nonaqueous electrolyte was prepared.
[0217] After welding the band-like positive-electrode lead to the charge collector of the <production of electrode group> aforementioned positive electrode, welding a band-like negative-electrode lead to the charge collector of said negative electrode and winding said positive electrode and said negative electrode around a curled form through said separator between them, it fabricated in the shape of flat, and the electrode group was produced.
[0218] The laminate film with a thickness of 100 micrometers which covered both sides of aluminium foil with polypropylene was fabricated to saccate, and it contained so that the laminating side shown in drawing 3 which mentioned said electrode group above in this might be in sight from opening in a bag. The polyvinylidene fluoride (PVdF) which is the giant molecule which has an adhesive property was dissolved in the dimethyl formamide (the boiling point is 153 degrees C) which is an organic solvent 0.3% of the weight. While the obtained solution is poured in so that the amount per cell capacity 100mAh may be set to 0.2ml at the electrode group in said laminate film, and making said solution permeate the interior of said electrode group, it was made to adhere to the whole front face of said electrode group.
[0219] Subsequently, said organic solvent was evaporated by performing a vacuum drying to the electrode group in said laminate film at 80 degrees C for 12 hours, and porosity jointing was formed in the front face of said electrode group while making the macromolecule which has an adhesive property in the opening of a positive electrode, a negative electrode, and a separator hold. The total amount of PVdF was 0.6mg per cell capacity 100mAh.
[0220] It pours into the electrode group in said laminate film so that the amount per cell capacity 1Ah may be set to 4.7g in said nonaqueous electrolyte, and it has drawing 1 mentioned above and the structure shown in 2, and thickness assembled the thin nonaqueous electrolyte rechargeable battery 40mm and whose height 3mm

and width of face are 70mm.
[0221] The following measures were taken as an initial charge process to this nonaqueous electrolyte rechargeable battery. First, after leaving 5h under 40-degree C hot environments, constant current and constant-potential charge were performed to 4.2V by 0.2C (120mA) under the environment for 10 hours. It discharged to 2.7V by 0.2C after that, and charged on the conditions as 1 cycle eye also with the still more nearly same two-cycle eye, and the nonaqueous electrolyte rechargeable battery was manufactured.
[0222] The capacity of a non-aqueous-solvent rechargeable battery and the 1kHz internal impedance which were acquired were measured. Moreover, in order to investigate a high current discharge property, the capacity maintenance factor at the time of 2C discharge at a room temperature (20 degrees C) was measured. Moreover, in order to investigate a charge-and-discharge cycle property, the cycle of 3-hour charge of the 4.2V constant current and the constant voltage in a 0.5C rate and 2.7V discharge of 1C rate was repeated, and the capacity maintenance factor after 300 cycles was measured. Moreover, bulging after high temperature storage of 120 hours was measured at 85 degrees C after 4.2V charge. The above the electrolytic-solution presentation, initial charge conditions, and cell property of a cell of an example 1 are shown in Table 1.
[0223] (An example 2 - example 7) Except having changed, as the presentation of the solvent of the electrolytic solution was shown in Table 1, the thin nonaqueous electrolyte rechargeable battery was obtained like the example 1, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of each example are shown in Table 1.
[0224] (Example 8) As a sheathing material, the aluminium can whose thickness is 0.2mm was used, and the example 8 did not add the macromolecule which has an adhesive property, but except having made outside ** into 3.2mm in thickness, width of face of 40mm, and height of 70mm, it obtained the thin nonaqueous electrolyte rechargeable battery as well as the thin nonaqueous electrolyte rechargeable battery of an example 1, and performed cell evaluation. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of an example 8 are shown in Table 1.
[0225] (An example 9 - example 11) Except having changed, as an example 1 and the temperature at the time of an initial charge were shown in Table 1, the thin nonaqueous electrolyte rechargeable battery was obtained like the example 1, and cell evaluation was performed. The electrolytic-solution presentation of the cell of each example, initial charge conditions, and the property of a cell are shown in Table 1.
[0226] (Examples 12 and 13) Except having changed, as the presentation of the solvent of the electrolytic solution was shown in Table 1, the thin nonaqueous electrolyte rechargeable battery was obtained like the example 1, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of each example are shown in Table 1.
[0227] (Example 1 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL 100% as nonaqueous electrolyte. The thin nonaqueous electrolyte rechargeable battery was obtained like the example 1 except using what was dissolved, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 1 of a comparison are shown in Table 2.
[0228] (Example 2 of a comparison) It is 1.5 mols [/l.] LiBF4 in nonaqueous electrolyte to the mixed solvent (rate 50:25:25 of a volume ratio) of BL, and EC and MEC. Except using what was dissolved, the same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 2 of a comparison are shown in Table 2.
[0229] (Example 3 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL and EC (rate 50:50 of a volume ratio) in nonaqueous electrolyte. Using what was dissolved, except having changed the temperature and the charge rate at the time of an initial charge, the same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 3 of a comparison are shown in Table 2.
[0230] (Example 4 of a comparison) The same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained except using for nonaqueous electrolyte what dissolved one mol [/l.] LiPF6 at BL and MEC (rate 25:75 of a volume ratio), and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 4 of a comparison are shown in Table 2.
[0231] (Example 5 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL and EC (rate 25:75 of a volume ratio) in nonaqueous electrolyte. The same thin nonaqueous electrolyte rechargeable battery as an example 1 was

obtained except using what was dissolved, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 5 of a comparison are shown in Table 2.
[0232] (Example 6 of a comparison) It is 0.8 mols [/l.] LiPF6 to BL and EC (rate 50:50 of a volume ratio) in nonaqueous electrolyte. The same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained using what was dissolved except having made temperature at the time of an initial charge into 25 degrees C, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 6 of a comparison are shown in Table 2.
[0233] (Example 7 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL and EC (rate 50:50 of a volume ratio) in nonaqueous electrolyte. The same thin nonaqueous electrolyte rechargeable battery as an example 8 was obtained using what was dissolved except having made temperature at the time of an initial charge into 25 degrees C, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 7 of a comparison are shown in Table 2.
[0234] (Example 8 of a comparison) The same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained except having made temperature at the time of an initial charge into 25 degrees C at nonaqueous electrolyte at BL and EC (rate 99:1 of a volume ratio) using what dissolved 1.5 mols [/l.] LiBF4, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 8 of a comparison are shown in Table 2.
[0235] (Example 9 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL, and EC and DEC (rate 50:25:25 of a volume ratio) in nonaqueous electrolyte. The same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained except using what was dissolved, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 9 of a comparison are shown in Table 2.
[0236] (Example 10 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL, and EC and MEC (rate 50:25:25 of a volume ratio) in nonaqueous electrolyte. The same thin nonaqueous electrolyte rechargeable battery as an example 1 was obtained except using what was dissolved, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 10 of a comparison are shown in Table 2.
[0237] (Example 11 of a comparison) It is 1.5 mols [/l.] LiBF4 to BL, and PC and EC (rate 50:25:25 of a volume ratio) as nonaqueous electrolyte. The thin nonaqueous electrolyte rechargeable battery was obtained like the example 1 except using what was dissolved, and cell evaluation was performed. The electrolytic-solution presentation, initial charge conditions, and cell property of a cell of the example 11 of a comparison are shown in Table 2.
[0238]
[Table 1]

	電解液組成		初充電条件（温度／充電レート）	容量(Ah)	内部インピーダンス（m・Ω）	容量と内部インピーダンスの積（m・Ω Ah）	２Ｃ放電時容量維持率（%）	300サイクル後容量維持率（%）	85℃貯蔵後膨れ（%）
	溶媒	電解質／濃度							
実施例１	75%BL 25%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.60	80	48	85	90	3
実施例２	90%BL 10%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.62	75	46.5	90	90	2
実施例３	95%BL 5%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.63	70	44.1	90	85	1
実施例４	60%BL 40%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.57	90	51.3	70	80	5
実施例５	75%BL 15%EC 10%DEC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.65	65	42.25	90	93	8
実施例６	75%BL 15%EC 10%MEC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.65	65	42.25	90	94	8
実施例７	75%BL 25%EC	LiPF6／0.8mol/l	40℃／0.2Ｃ	0.60	80	48	80	80	5
実施例８	75%BL 25%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.60	85	51	85	90	0.5
実施例９	75%BL 25%EC	LiBF4／1.5mol/l	30℃／0.2Ｃ	0.50	100	50	60	80	3
実施例10	75%BL 25%EC	LiBF4／1.5mol/l	60℃／0.2Ｃ	0.62	75	46.5	85	85	3
実施例11	75%BL 25%EC	LiBF4／1.5mol/l	80℃／0.2Ｃ	0.45	100	45	50	70	2
実施例12	55%BL 45%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.57	90	51.3	65	82	5
実施例13	65%BL 35%EC	LiBF4／1.5mol/l	40℃／0.2Ｃ	0.60	85	51	83	90	3

[0239]
[Table 2]

	電解液組成 溶媒	電解液組成 電解質／濃度	初充電条件 (温度／充電レート)	容量 (Ah)	内部インピーダンス (m・Ω)	容量と内部インピーダンスの積 (m・Ω Ah)	2C放電時容量維持率 (%)	300サイクル後容量維持率 (%)	85℃貯蔵後膨れ (%)
比較例1	100%BL	LiBF4／1.5mol/l	40℃／0.2C	0.4	300	120	10	10	1
比較例2	50%BL 25%EC 25%MEC	LiBF4／1.5mol/l	40℃／0.2C	0.4	150	60	30	50	5
比較例3	50%BL 50%EC	LiBF4／1.5mol/l	25℃／1C	0.4	300	120	40	20	3
比較例4	25%EC 75%MEC	LiPF6／1mol/l	40℃／0.2C	0.6	80	48	20	85	50
比較例5	25%BL 75%EC	LiBF4／1.5mol/l	40℃／0.2C	0.3	500	150	10	20	20
比較例6	50%BL 50%EC	LiPF6／0.8mol/l	25℃／0.2C	0.3	400	120	30	20	100
比較例7	50%BL 50%EC	LiBF4／1.5mol/l	25℃／0.2C	0.3	400	120	20	50	10
比較例8	99%BL 1%EC	LiBF4／1.5mol/l	25℃／0.2C	0.3	400	120	30	10	10
比較例9	50%BL 25%EC 25%DEC	LiBF4／1.5mol/l	40℃／0.2C	0.4	150	60	50	60	100
比較例10	50%BL 25%EC 25%MEC	LiBF4／1.5mol/l	40℃／0.2C	0.4	150	60	60	60	100
比較例11	50%BL 25%EC 25%PC	LiBF4／1.5mol/l	40℃／0.2C	0.25	300	75	40	20	5

[0240] There is more thickness than a sheathing material 0.3mm or less and 50 volume %, and it turns out that the rechargeable battery of the examples 1-13 equipped with the nonaqueous electrolyte containing the non-aqueous solvent containing BL below 95 volume % can control that a sheathing material blisters, and can improve the discharge capacity in 2C, and the capacity maintenance factor after 300 cycles at the time of elevated-temperature storage so that clearly from Table 1 and Table 2.
[0241] on the other hand, example of comparison 1- although the rechargeable battery of 3 and 11 can control bulging of the sheathing material at the time of elevated-temperature storage, it turns out that the discharge capacity in 2C and the capacity maintenance factor after 300 cycles are inferior compared with examples 1-13. Moreover, the rechargeable battery of the examples 4-10 of a comparison is understood that bulging of the sheathing material at the time of elevated-temperature storage is large compared with examples 1-13. In addition, the nonaqueous electrolyte contained in the rechargeable battery of the example 1 of a comparison is

.equivalent to the nonaqueous electrolyte indicated by JP,11-97062,A mentioned above. Moreover, the nonaqueous electrolyte contained in the rechargeable battery of the example 11 of a comparison is equivalent to the nonaqueous electrolyte indicated by JP,4-14769,A mentioned above.
[0242] (Example 14) the aluminium can whose thickness is 0.35mm as a sheathing material -- using -- a cell dimension -- an example 1 -- being the same (40mm and height being [thickness] 70mm for 3mm and width of face) -- the thin nonaqueous electrolyte rechargeable battery was manufactured like the example 1 mentioned above except making thickness of an electrode group thin so that it may become. The capacity of the obtained rechargeable battery was 0.4Ah(s).
[0243] (Example 15) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 1 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 1 volume %l. as nonaqueous electrolyte.
[0244] (Example 16) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 1 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 23 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 2 volume %l. as nonaqueous electrolyte.
[0245] (Example 17) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 1 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24.5 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 0.5 volume %l. as nonaqueous electrolyte.
[0246] (Example 18) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 1 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 25 volume %, gamma-butyrolactone (BL) of 74 volume %, and toluene of 1 volume %l. as nonaqueous electrolyte.
[0247] About the rechargeable battery of the acquired examples 15-18, as the example 1 mentioned above explained, bulging after storage is measured at capacity, internal impedance, the capacity maintenance factor at the time of 2C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C, and the result is shown in the following table 3.
[0248]
[Table 3]

	第３溶媒の種類	第３溶媒比率 (vol%)	容量 (Ah)	内部インピーダンス (mΩ)	容量と内部インピーダンスの積 (mΩ・Ah)	２C放電容量維持率 (%)	300サイクル後維持率 (%)	８５℃貯蔵後膨れ (%)
実施例 15	ＶＣ	1	０．６２	７５	４６．５	９０	９４	4
実施例 16	ＶＣ	2	０．６２	７５	４６．５	９０	９５	４．５
実施例 17	ＶＣ	０．５	０．６１	７８	４７．５８	８８	９２	３
実施例 18	トルエン	1	０．６２	７５	４６．５	８５	８８	３

[0249] And the rechargeable battery of the examples 15-17 equipped with the nonaqueous electrolyte containing BL, EC, and VC below 95 volume % and the rechargeable battery of the example 18 equipped with the nonaqueous electrolyte which there is than 50 volume % and contains BL, EC, and the aromatic compound below 95 volume % are understood that the capacity maintenance factor after 300 cycles is high than 50 volume % compared with the rechargeable battery of an example 1 so that clearly from Table 3. [more]
[0250] (Example 19) As a separator, thickness manufactured the thin nonaqueous electrolyte rechargeable battery by 25 micrometers like the example 1 which 120 degrees C and a heat shrink in 1 hour mentioned above except air transmission using 90sec(s) / porosity film made from polyethylene whose porosity it is 3 100cm and is 50% at 20%.
[0251] (Example 20) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 19 which mentioned above the air permeability of the porosity film of a separator except 580sec(s) / 3 costing

.100cm.
[0252] (Example 21) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 19 which mentioned above the air permeability of the porosity sheet of a separator except 400sec(s) / 3 costing 100cm.
[0253] (Example 22) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 19 which mentioned above the air permeability of the porosity sheet of a separator except 150sec(s) / 3 costing 100cm.
[0254] About the rechargeable battery of the acquired examples 19-22, as the example 1 mentioned above explained, bulging after storage is measured at capacity, internal impedance, the capacity maintenance factor at the time of 2C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C, and the result is shown in the following table 4.
[0255]
[Table 4]

	セパレータ空気透過率 (sec/100cm^3)	容量 (Ah)	内部インピーダンス (mΩ)	容量と内部インピーダンスの積 (mΩ・Ah)	2C放電容量維持率 (%)	300サイクル後維持率 (%)	85℃貯蔵後膨れ (%)
実施例19	90	0.61	70	42	90	95	3
実施例20	580	0.55	120	60	50	70	3
実施例21	400	0.56	100	55	60	75	3
実施例22	150	0.58	90	52.2	86	83	3

[0256] (Example 23) Except not adding the macromolecule which has an adhesive property, as the example 1 mentioned above explained, the electrode group was produced. The thickness which is a sheathing material contained the obtained electrode group to the aluminium can which is 0.20mm. Subsequently, by pressing in said sheathing material by the pressure of 10kg/cm2 along the thickness direction of an electrode group in a 80-degree C elevated-temperature vacuum ambient atmosphere, heat curing of the binder contained in said positive electrode and negative electrode in a positive electrode, a negative electrode, and a separator was carried out, and it unified.
[0257] The 4 1.5 mol [/] fluoride (LiBF4) of lithium borate was dissolved in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24.5 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 0.5 volume %l., and nonaqueous electrolyte was prepared. Said nonaqueous electrolyte was poured into the electrode group in said aluminium can so that the amount per cell capacity 1Ah might become being the same as that of 4.7g, and thickness assembled the thin nonaqueous electrolyte rechargeable battery 40mm and whose height 3.2mm and width of face are 70mm by obturating.
[0258] (Example 24) Except not adding the macromolecule which has an adhesive property, as the example 1 mentioned above explained, the electrode group was produced. The thickness which is a sheathing material contained the obtained electrode group to the aluminium can which is 0.20mm. Subsequently, by pressing in said sheathing material by the pressure of 10kg/cm2 along the thickness direction of an electrode group in a 80-degree C elevated-temperature vacuum ambient atmosphere, heat curing of the binder contained in said positive electrode and negative electrode in a positive electrode, a negative electrode, and a separator was carried out, and it unified.
[0259] The 4 1.5 mol [/] fluoride (LiBF4) of lithium borate was dissolved in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 23 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 2 volume %l., and nonaqueous electrolyte was prepared. Said nonaqueous electrolyte was poured into the electrode group in said aluminium can so that the amount per cell capacity 1Ah might become being the same as that of 4.7g, and thickness assembled the thin nonaqueous electrolyte rechargeable battery 40mm and whose height 3.2mm and width of face are 70mm.
[0260] About the rechargeable battery of the acquired examples 23-24, as the example 1 mentioned above explained, bulging after storage is measured at capacity, internal impedance, the capacity maintenance factor at

the time of 2C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C, and the result is shown in the following table 5.
[0261]
[Table 5]

	容量 (Ah)	内部インピーダンス (mΩ)	容量と内部インピーダンスの積 (mΩ・Ah)	２Ｃ放電容量維持率 (%)	300サイクル後維持率 (%)	８５℃貯蔵後膨れ (%)
実施例23	０．６１	７８	４７．５８	８８	９２	０．５
実施例24	０．６２	７５	４６．５	９０	９５	０．７

[0262] The rechargeable battery of examples 23-24 is high capacity, and the capacity maintenance factor after the time of 2C discharge and 300 cycles is high, and it turns out that bulging at the time of storing at 85 degrees C can be controlled so that clearly from Table 5.
[0263] (Example 25) The nonaqueous electrolyte rechargeable battery was manufactured like the example 1 mentioned above except 4mm and width of face setting it 100mm, and height setting [thickness] a cell dimension to 280mm as a sheathing material, using a laminate film with a thickness of 500 micrometers which covered both sides of aluminum foil with polypropylene.
[0264] About the rechargeable battery of the acquired example 25, as the example 1 mentioned above explained, bulging after storage was measured at capacity, the capacity maintenance factor at the time of 2C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C. Consequently, capacity was 6Ah (s), the capacity maintenance factor was 85% at the time of 2C discharge, the capacity maintenance factor after 300 cycles was 90%, and bulging after 85-degree-C storage of the rechargeable battery of an example 25 was 3%. Therefore, and when the non-aqueous solvent containing BL below 95 volume % was used, it has checked that the laminate film whose thickness is 0.5mm as a sheathing material of a large-sized cell like an electric vehicle could be used than 50 volume %.
[0265] (Example 26)
<production of a positive electrode> -- first -- a lithium cobalt oxide (Lix CoO2; however) X 91 % of the weight of powder which is 0<=X<=1 2.5 % of the weight of acetylene black, Add [both] 3 % of the weight of graphite, 4 % of the weight (PVdF) of polyvinylidene fluorides, and N-methyl pyrrolidone (NMP) solution, and it mixes. Consistencies are 3.3 g/cm3 to each field of a charge collector by drying and pressing, after applying to both sides of the charge collector with which thickness consists of aluminium foil which is 10 micrometers. Voidage produced the positive electrode of the structure where the positive-active-material layer whose thickness is 48 micrometers was supported with 34%.
[0266] The powder of a mesophase pitch based carbon fiber (for 8 micrometers and mean fiber length, 20 micrometers and an average spacing (d002) are [the diameter of fiber] 0.3360nm) heat-treated at 3000 degrees C as a <production of negative electrode> carbonaceous ingredient 93 % of the weight, By mixing N-methyl pyrrolidone solution with 7 % of the weight (PVdF) of polyvinylidene fluorides as a binder, applying this to both sides of the charge collector with which thickness consists of copper foil which is 10 micrometers, and drying and pressing it in them A consistency is 3 1.3g/cm to each side of a charge collector. Voidage produced the negative electrode of the structure where the negative-electrode active material layer whose thickness is 45 micrometers was supported with 41%.
[0267] The separator which consists of a porosity film made from polyethylene whose <separator> thickness is 20 micrometers, and whose porosity is 50% was prepared.
[0268] After winding the <production of electrode group> aforementioned positive electrode, and said negative electrode around a curled form through said separator between them, it fabricated in the shape of flat, and thickness produced the flat electrode group 30mm and whose height 2.5mm and width of face are 50mm.
[0269] <Preparation of nonaqueous electrolyte> 4 lithium borate fluoride (LiBF4) was dissolved in the mixed solvent (rate 25:75 of a mixed volume ratio) of ethylene carbonate (EC) and gamma-butyrolactone (BL) 1.5 mols / 1, and nonaqueous electrolyte was prepared.
[0270] Subsequently, the laminate film with a thickness of 100 micrometers which covered both sides of aluminum foil with polypropylene was fabricated to saccate, and said electrode group was contained to this, and

it faced across both sides with the holder so that thickness might be set to 2.7mm. The polyvinylidene fluoride (PVdF) which is the giant molecule which has an adhesive property was dissolved in the dimethyl formamide (the boiling point is 153 degrees C) which is an organic solvent 0.3% of the weight. While the obtained solution is poured in so that the amount per cell capacity 100mAh may be set to 0.6ml at the electrode group in said laminate film, and making said solution permeate the interior of said electrode group, it was made to adhere to the whole front face of said electrode group.
[0271] Subsequently, said organic solvent was evaporated by performing a vacuum drying to the electrode group in said laminate film at 80 degrees C for 12 hours, and porosity jointing was formed in the front face of said electrode group while making the macromolecule which has an adhesive property in the opening of a positive electrode, a negative electrode, and a separator hold.
[0272] Said nonaqueous electrolyte was poured into the electrode group in said laminate film so that the amount per cell capacity 1Ah might be set to 2g, and thickness assembled the thin nonaqueous electrolyte rechargeable battery 32mm and whose height 3mm and width of face are 55mm.
[0273] The following measures were taken as an initial charge process to this nonaqueous electrolyte rechargeable battery. First, after leaving 5h under 40-degree C hot environments, constant current and constant-potential charge were performed to 4.2V by 0.2C (120mA) under the environment for 10 hours. It discharged to 2.7V by 0.2C after that, and charged on the conditions as 1 cycle eye also with the still more nearly same two-cycle eye, and the nonaqueous electrolyte rechargeable battery was manufactured.
[0274] In order to investigate the high current discharge property in the room temperature (20 degrees C) of the obtained non-aqueous-solvent rechargeable battery, the capacity maintenance factor at the time of 3C discharge was measured. Under the present circumstances, discharge capacity in 0.2C was made into reference capacity. Moreover, in order to investigate a charge-and-discharge cycle property, the cycle of 3-hour charge of the 4.2V constant current and the constant voltage in a 0.7C rate and 2.7V discharge of 1C rate was repeated, and the capacity maintenance factor after 300 cycles was measured. Moreover, bulging after high temperature storage of 120 hours was measured at 85 degrees C after 4.2V charge. The initial capacity of the cell of the above example 26, active material layer thickness, the content ratio of the gamma-butyrolactone of the solvent of the electrolytic solution, and a cell property are shown in Table 6.
[0275] (Examples 27-37, A and B, and examples 12-13 of a comparison) Except having changed, as the thickness of one side of a positive-active-material layer and a negative-electrode active material layer and the content ratio of the gamma-butyrolactone of the solvent of the electrolytic solution were shown in Table 6, the thin nonaqueous electrolyte rechargeable battery was obtained like the example 26, and cell evaluation was performed. The initial capacity of each cell, active material layer thickness, the content ratio of the gamma-butyrolactone of the solvent of the electrolytic solution, and a cell property are written together to Table 6.
[0276]
[Table 6]

	容量 (Ah)	正極活物質層片面厚さ (μm)	負極活物質層片面厚さ (μm)	BL含有比率 (体積%)	3C放電時容量維持率 (%)	300サイクル容量維持率 (%)	85℃貯蔵膨れ (%)
実施例26	0.32	48	45	75	96	90	3
実施例27	0.35	60	56	75	92	80	3
実施例28	0.30	39	36	75	98	93	3
実施例29	0.25	24	23	75	99	94	3
実施例30	0.12	10	9.5	75	98	88	2
実施例31	0.30	48	45	60	90	80	4
実施例32	0.31	48	45	70	95	82	3
実施例33	0.33	48	45	90	97	92	2
実施例34	0.31	48	45	95	98	80	1
実施例35	0.28	48	45	40	80	80	6
実施例36	0.36	60	65	75	90	82	3
実施例37	0.38	80	80	75	80	75	3
実施例A	0.35	87	90	75	50	50	3
実施例B	0.05	8	8	75	80	85	2
比較例12	0.30	105	108	30	20	30	6
比較例13	0.10	8	8	30	40	60	6

[0277] It turns out that the examples 26-37 equipped with the nonaqueous electrolyte containing the positive electrode whose thickness of a positive-active-material layer is 10-100 micrometers, and the non-aqueous solvent in which thickness contains a sheathing material 0.3mm or less and BL of 40 - 95 volume %, and the rechargeable battery of A and B can control that a sheathing material blisters, and can improve initial capacity, the discharge capacity in 3C, and the capacity maintenance factor after 300 cycles at the time of elevated-temperature storage so that clearly from Table 6.
[0278] On the other hand, it turns out that the rechargeable battery of the example 12 of a comparison is inferior in the discharge capacity in 3C, and the capacity maintenance factor after 300 cycles compared with examples 26-37, and A and B. Moreover, it turns out that the discharge capacity in 3C is inferior in the rechargeable battery of the example 13 of a comparison compared with examples 26-37, and A and B.
[0279] (Example 38) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 26 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24.9 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 0.1 volume %l. as nonaqueous electrolyte.
[0280] (Example 39) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 26 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 1 volume %l. as nonaqueous electrolyte.
[0281] (Example 40) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 26 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 20 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 5 volume %l. as nonaqueous electrolyte.
[0282] (Example 41) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 26 mentioned above except using what dissolved the 4 1.5 mol [/] fluoride (LiBF4) of lithium borate in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 25 volume %, gamma-butyrolactone (BL) of 74 volume %, and toluene of 1 volume %l. as nonaqueous electrolyte.
[0283] About the rechargeable battery of the acquired examples 38-41, as the example 26 mentioned above explained, bulging after storage is measured at capacity, the capacity maintenance factor at the time of 3C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C, and the result is shown in the following table 7.
[0284]

[Table 7]

	第３溶媒の種類	第３溶媒比率 (vol%)	容量 (Ah)	３Ｃ放電容量維持率 (%)	300サイクル後維持率 (%)	８５℃貯蔵後膨れ (%)
実施例 38	ＶＣ	０．１	０．３２	９６	９２	３
実施例 39	ＶＣ	１	０．３３	９６	９６	４
実施例 40	ＶＣ	５	０．３０	９２	９３	６
実施例 41	トルエン	１	０．３２	８８	９０	３

[0285] The rechargeable battery of the example 41 equipped with the nonaqueous electrolyte containing the rechargeable battery of the examples 38-40 equipped with the nonaqueous electrolyte containing BL, EC, and VC of 40 - 95 volume %, and BL, EC and the aromatic compound of 40 - 95 volume % is understood that the capacity maintenance factor after 300 cycles is high compared with the rechargeable battery of an example 26 so that clearly from Table 7.
[0286] (Example 42) As a separator, thickness manufactured the thin nonaqueous electrolyte rechargeable battery by 25 micrometers like the example 26 which 120 degrees C and a heat shrink in 1 hour mentioned above except air transmission using 90sec(s) / porosity film made from polyethylene whose porosity it is 3 100cm and is 50% at 20%.
[0287] (Example 43) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 42 which mentioned above the air permeability of the porosity film of a separator except 580sec(s) / 3 costing 100cm.
[0288] (Example 44) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 42 which mentioned above the air permeability of the porosity sheet of a separator except 400sec(s) / 3 costing 100cm.
[0289] (Example 45) The thin nonaqueous electrolyte rechargeable battery was manufactured like the example 42 which mentioned above the air permeability of the porosity sheet of a separator except 150sec(s) / 3 costing 100cm.
[0290] About the rechargeable battery of the acquired examples 42-45, as the example 26 mentioned above explained, bulging after storage is measured at capacity, the capacity maintenance factor at the time of 3C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C, and the result is shown in the following table 8.
[0291]
[Table 8]

	セパレータ空気透過率 ($sec/100cm^3$)	容量 (Ah)	３Ｃ放電容量維持率 (%)	300サイクル後維持率 (%)	８５℃貯蔵後膨れ (%)
実施例 42	９０	０．３１	９７．５	９５	３
実施例 43	５８０	０．２５	８０	７０	２．８
実施例 44	４００	０．２６	８５	７５	２．８
実施例 45	１５０	０．２８	９５	８８	３

[0292] (Example 46) Except not adding the macromolecule which has an adhesive property, as the example 26 mentioned above explained, the electrode group was produced. The thickness which is a sheathing material contained the obtained electrode group to the aluminium can which is 0.18mm. Subsequently, by pressing in said sheathing material by the pressure of 10kg/cm2 along the thickness direction of an electrode group in a 80-degree C elevated-temperature vacuum ambient atmosphere, heat curing of the binder contained in said positive electrode and negative electrode in a positive electrode, a negative electrode, and a separator was carried out,

and it unified.
[0293] The 4 1.5 mol [/] fluoride (LiBF4) of lithium borate was dissolved in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24.5 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 0.5 volume %l., and nonaqueous electrolyte was prepared. Said nonaqueous electrolyte was poured into the electrode group in said aluminium can so that the amount per cell capacity 1Ah might become being the same as that of 4.7g, and thickness assembled the thin nonaqueous electrolyte rechargeable battery 32mm and whose height 3mm and width of face are 55mm by obturating.
[0294] (Example 47) Except not adding the macromolecule which has an adhesive property, as the example 26 mentioned above explained, the electrode group was produced. The thickness which is a sheathing material contained the obtained electrode group to the aluminium can which is 0.25mm. Subsequently, by pressing in said sheathing material by the pressure of 10kg/cm2 along the thickness direction of an electrode group in a 80-degree C elevated-temperature vacuum ambient atmosphere, heat curing of the binder contained in said positive electrode and negative electrode in a positive electrode, a negative electrode, and a separator was carried out, and it unified.
[0295] The 4 1.5 mol [/] fluoride (LiBF4) of lithium borate was dissolved in the non-aqueous solvent which consists of the ethylene carbonate (EC) of 24 volume %, gamma-butyrolactone (BL) of 75 volume %, and vinylene carbonate (VC) of 2 volume %l., and nonaqueous electrolyte was prepared. Said nonaqueous electrolyte was poured into the electrode group in said aluminium can so that the amount per cell capacity 1Ah might become being the same as that of 4.7g, and thickness assembled the thin nonaqueous electrolyte rechargeable battery 32mm and whose height 3mm and width of face are 55mm.
[0296] About the rechargeable battery of the acquired examples 46-47, as the example 26 mentioned above explained, bulging after storage is measured at capacity, the capacity maintenance factor at the time of 3C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C, and the result is shown in the following table 9.
[0297]
[Table 9]

	容量 (Ah)	３Ｃ放電 容量維持率 (%)	300サイクル後 維持率 (%)	８５℃貯蔵後 膨れ (%)
実施例46	０．３２	９６	９５	０．５
実施例47	０．３３	９６	９７	０．６

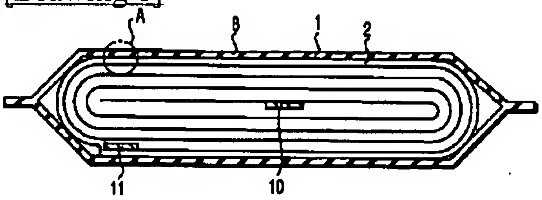
[0298] The rechargeable battery of examples 46-47 is high capacity, and the capacity maintenance factor after the time of 3C discharge and 300 cycles is high, and it turns out that bulging at the time of storing at 85 degrees C can be controlled so that clearly from Table 9.
[0299] (Example 48) The nonaqueous electrolyte rechargeable battery was manufactured like the example 26 mentioned above except 4mm and width of face setting it 80mm, and height setting [thickness] a cell dimension to 220mm as a sheathing material, using a laminate film with a thickness of 500 micrometers which covered both sides of aluminum foil with polypropylene.
[0300] About the rechargeable battery of the acquired example 48, as the example 26 mentioned above explained, bulging after storage was measured at capacity, the capacity maintenance factor at the time of 3C discharge, the capacity maintenance factor after 300 cycles, and 85 degrees C. Consequently, capacity was 3.2Ah(s), the capacity maintenance factor was 96% at the time of 3C discharge, the capacity maintenance factor after 300 cycles was 90%, and bulging after 85-degree-C storage of the rechargeable battery of an example 48 was 3%. Therefore, when the non-aqueous solvent which sets thickness of a positive-active-material layer to 10-100 micrometers, and contains BL of 40 - 95 volume % was used, it has checked that the laminate film whose thickness is 0.5mm as a sheathing material of a large-sized cell like an electric vehicle could be used.
[0301]
[Effect of the Invention] As explained in full detail above, according to this invention, deformation of the sheathing material at the time of storing at an elevated temperature is controlled, and the nonaqueous electrolyte rechargeable battery weight energy density, volume energy density, the high current discharge property, and

whose charge-and-discharge cycle property improved can be offered.

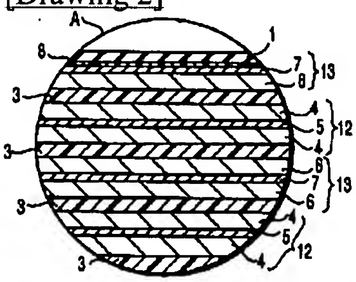
[Translation done.]

DRAWINGS

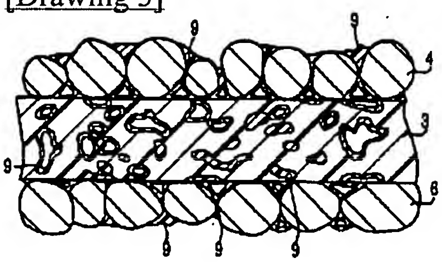
[Drawing 1]



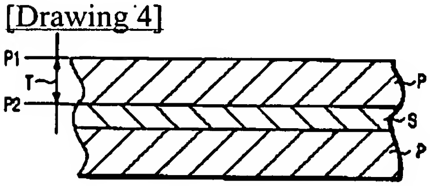
[Drawing 2]



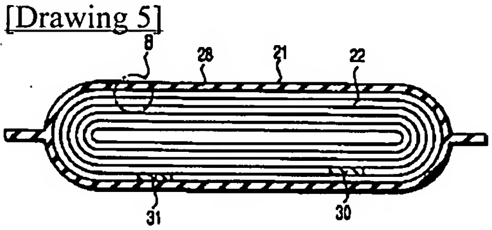
[Drawing 3]



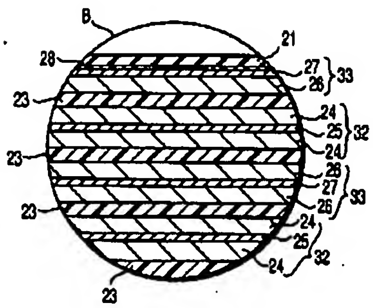
[Drawing 4]



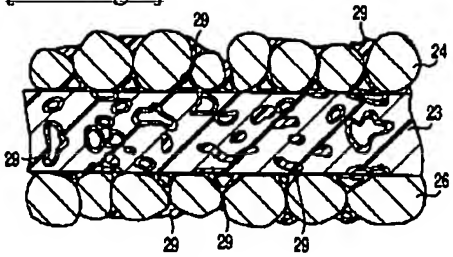
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]